Instruction Manual

MODEL 891A
& 891AR

DC DIFFERENTIAL
VOLTMETER

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
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MODEL 891A & 891AR

DC DIFFERENTIAL VOLTMETER

891A & 891AR serial no. _____ and above.

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THE MODEL 891A DC DIFFERENTIAL VOLTMETER

THE MODEL 891AR DC DIFFERENTIAL VOLTMETER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Fluke Model 891A and AR DC Differential Voltmeters provide conventional or differential measurement of voltages from 10 microvolts to 1100 volts dc. Conventional (TVM) measurements with an accuracy of ±3% of the selected range are available and are normally made to initially determine the relative magnitude of the measured dc voltage. The differential (NULL) mode is then used with an improved accuracy of up to 250% over that of the conventional mode to determine the precise magnitude of the measured dc voltage. One linear meter scale greatly simplifies all measurements made with the instrument. Whenever the instrument is operated on the differential mode, an in-line digital readout representing the magnitude of the measured voltage is available from the front panel readout dials.

1-3. Two versions of the instrument are available and are identified as the Model 891A and the Model 891AR. The Model 891A is a portable unit, half-rack in width, with a tilt-down carrying handle. This handle detents into the instrument's feet to serve as a tilt bale during bench top use of the instrument. The Model 891AR is also a portable unit, but is of proper width for relay rack installation. Carrying of this instrument is provided by two front panel handles while a tilt bale located on the bottom of the instrument facilitates bench top use.

1-4. A rechargeable battery option and a recorder output option are available for either version of the instrument. These options can be installed at the factory, upon request, or in the field. Option Kit 891A-7001 comprises the rechargeable battery pack and when installed in the instrument is identified as the -01 option on the rear panel decal. Option Kit 891A-7002 comprises the recorder output and when installed in the instrument is identified as the -02 option on the rear panel decal.

1-5. ELECTRICAL SPECIFICATIONS

1-6. DIFFERENTIAL VOLTMETER

ABSOLUTE ACCURACY
±(0.01% of input +0.001% of range +10 uv) from 0 to ±1100 volts dc at 23°C ±2°C at up to 80% relative humidity.
±(0.02% of input +0.001% of range +10 uv) from 0 to ±1100 volts dc from 10°C to 40°C (50°F to 104°F) at up to 70% relative humidity.

INPUT AND NULL VOLTAGE RANGES

INPUT RANGE	NULL RANGES
1	0.001, 0.01, 0.1
10	0.001, 0.01, 0.1, 1.0
100	0.01, 0.1, 1.0, 10
1000	0.1, 1.0, 10, 100

INPUT RESISTANCE
Infinite at null from 0 to 1100 volts dc.

METER RESOLUTION

INPUT RANGE (VOLTS)	RESOLUTION PPM OF RANGE	RESOLUTION VOLTAGE
1	10	10 uv
10	1	10 uv
100	1	100 uv
1000	1	10 mv

VOLTAGE DIAL RESOLUTION

INPUT RANGE (VOLTS)	RESOLUTION PPM OF RANGE	RESOLUTION VOLTAGE
1	10	10 uv
10	10	100 uv
100	10	1 mv
1000	10	10 mv

1-7. CONVENTIONAL VOLTMETER (TVM)

ACCURACY
±3% of range.

RANGES AND INPUT RESISTANCE

INPUT RANGE (VOLTS)	INPUT RESISTANCE (MEGOHMS)
1000	100
100	100
10	100
1	100
*0.1-0-0.1	100
*0.01-0-0.01	10
*0.001-0-0.001	10

10% over-ranging on each range
*These ranges obtained using null ranges with all Readout dials at zero.

1-8. GENERAL SPECIFICATIONS

ELECTRICAL DESIGN
Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR
10 megohms on the 0.01 and 0.001 volt ranges and 100 megohms on all other ranges.

REFERENCE ELEMENT
Temperature compensated zener diodes.

REGULATION OF REFERENCE SUPPLY
0.0005% for a 10% line voltage change.

INSTRUMENT STABILITY (Peak-to-Peak)
10 ppm per hour
20 ppm per day
40 ppm per month
90 ppm per year

KELVIN-VARLEY DIVIDER ACCURACY
±0.005% of dial setting above 1/10 of full-scale.

RECORDER OUTPUT
Available as the -02 option, adjustable from 0 to ±0.2 volts for an end-scale meter deflection. Low side is grounded and loading does not affect meter deflection accuracy.

POLARITY
Reversible with a front panel control.

WARMUP TIME
Less than one minute.

DC COMMON MODE REJECTION
120 db (1 uv/volt of common mode voltage) for maximum of ±500 volts.

AC COMMON MODE REJECTION
Up to 100 volts ac peak-to-peak, 50 to 500 Hz, produces no measurable instrument error.

INPUT POWER
115/230 volts ac, 50 to 500 Hz, at approximately 4 watts for line operation and approximately 8 watts when recharging batteries on the -01 option equipped instruments. Minimum of 8 hours of operation on fully charged batteries of the -01 option equipped instruments.

1-9. ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE RANGE
Within all specifications from 10°C to 40°C (50°F to 104°F), derated at 15 ppm/°C outside these limits to 0°C and 50°C (32°F and 122°F).

HUMIDITY
Within all specifications up to 80% R.H. below 25°C.
Within all specifications up to 70% R.H. above 25°C.

STORAGE TEMPERATURE RANGE
Model 891A/AR
-40°C to 70°C (-40°F to 158°F).
Model 891A/AR-01
-40°C to 60°C (-40°F to 140°F).

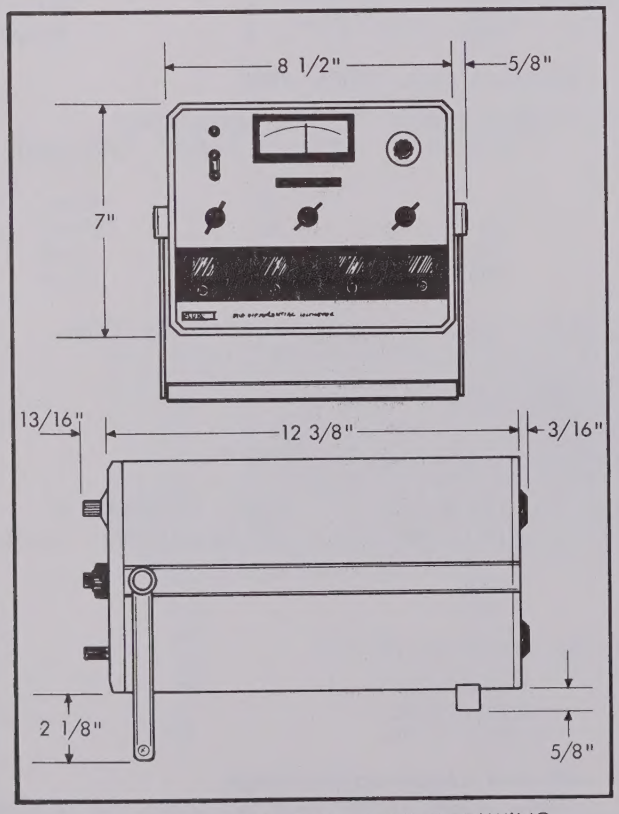


Figure 1-1. MODEL 891A OUTLINE DRAWING

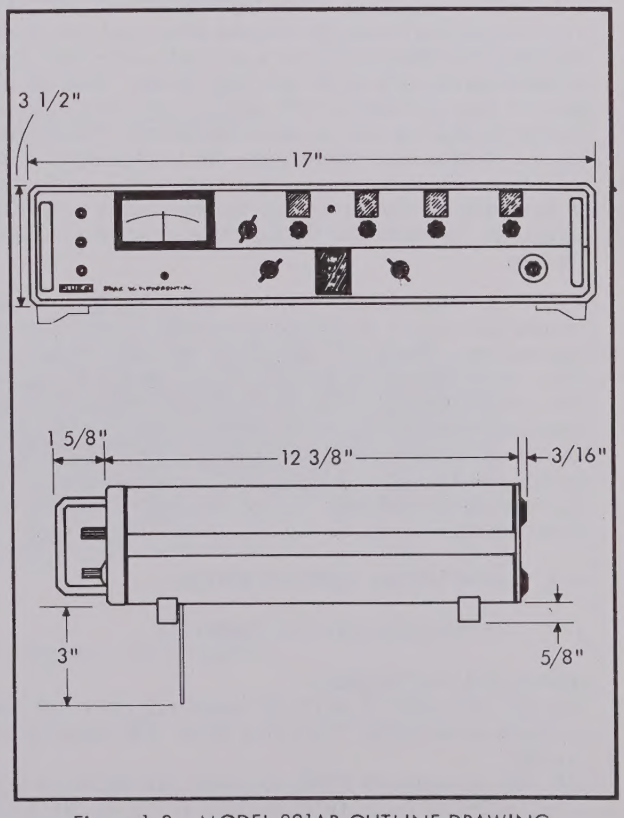


Figure 1-2. MODEL 891AR OUTLINE DRAWING

SHOCK
Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION
Meets requirements of MIL-T-945A.

1-10. MECHANICAL SPECIFICATIONS

SIZE
Model 891A - 10-1/4" wide x 7-5/8" high x 13-3/8" deep.
Model 891AR - 17" wide x 4-1/8" high x 14-3/16" deep. (19" wide upon installation of mounting brackets).

WEIGHT
Model 891A - Approximately 12 lbs.
Model 891AR - Approximately 12 lbs.
Option Kit 891A-7001 - Approximately 2 lbs.
Option Kit 891A-7002 - Approximately 0.3 lbs.

OPTION KIT 891A-7001
Provides a rechargeable battery pack for installation in both versions of the instrument.

OPTION KIT 891A-7002
Provides a recorder output for installation in both versions of the instrument.

SECTION II

OPERATING INSTRUCTIONS

2-1. INTRODUCTION

2-2. This section of the manual contains information necessary for you to effectively operate your Model 891 DC Differential Voltmeter. It is recommended that you thoroughly read and understand this section of the manual before attempting to operate your instrument.

2-3. Should any difficulties be encountered during the operation of your instrument, please feel free to contact your nearest John Fluke Sales Representative or write directly to the John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle, Washington 98133, with a statement of your problem. A complete list of Sales Representatives is contained at the rear of this manual.

2-4. OPERATING FEATURES

2-5. All of the controls, terminals, and indicators for the Model 891A and the Model 891AR are illustrated and described in Figure 2-1 and Figure 2-2.

2-6. OPERATION FROM 115/230 VOLT AC POWER LINES

2-7. The Model 891 may be operated from either a 115 or 230 volt ac power line. The input power transformer primary is composed of two windings which, when connected in parallel, allows the instrument to be operated from a 115 volt ac power line or, when the windings are connected in series, allows the instrument to be operated from a 230 volt ac power line.

2-8. A rear panel 115/230 slide switch (S5) provides the necessary power transformer primary winding connections when placed to the desired 115 or 230 volt position.

2-9. PRELIMINARY OPERATING PROCEDURES

2-10. Connect the Model 891 power cord to available line power. If your instrument does not contain the -01 option, perform only step a. If your instrument contains the -01 option, perform steps a through d.

WARNING!

The instrument case is connected to the round pin of the three-prong connector located on the power cord. Whenever the instrument is operated from ac line power, ensure that this round pin is connected to a high quality earth ground.

a. Place the instrument controls as follows and allow at least one minute of circuit stabilization before attempting any measurements.

POWER	ON/LINE OPR
RANGE	1000
NULLS SENS	TVM
POLARITY	+
Readout dials	000.00

Note!

The Readout dial labeled 00 in the preceding step, represents the extreme right-hand vernier dial.

b. Place the -01 option equipped instrument POWER switch to BAT CHK, observing that the meter needle deflects to the left of the -.2 volt increment. If the batteries are adequately charged, the instrument can be operated on battery power by placing the POWER switch to either BAT OPR or BAT OPR/LINE ISOL. To completely isolate your instrument from the line power ground, disconnect the power cord from line power.

c. If the BAT CHK test results in a deflection of less than .2 volts on the meter, place the POWER switch to BAT CHG and operate the instrument from line power until the batteries are adequately charged. All measurements can be performed during recharging of the batteries. Should the batteries fail the BAT CHK test after 16 hours of recharging, replacement of the batteries may be necessary. Refer to Section IV, paragraph 4-19 and 4-20 for battery replacement instructions.

2-11. OPERATIONAL TEST

2-12. The following information is provided for the operator to initially verify instrument operation. These tests will only check relative instrument operation and are not intended as instrument performance checks. Should you wish to check the accuracy of the instrument against the specifications contained in Section I, refer to the Performance Checks contained in Section IV of this manual.

2-13. To determine relative instrument operation, perform the operations described in the Preliminary Operating Procedures (paragraphs 2-9 and 2-10) and proceed as follows:

a. Place the RANGE control to 1.

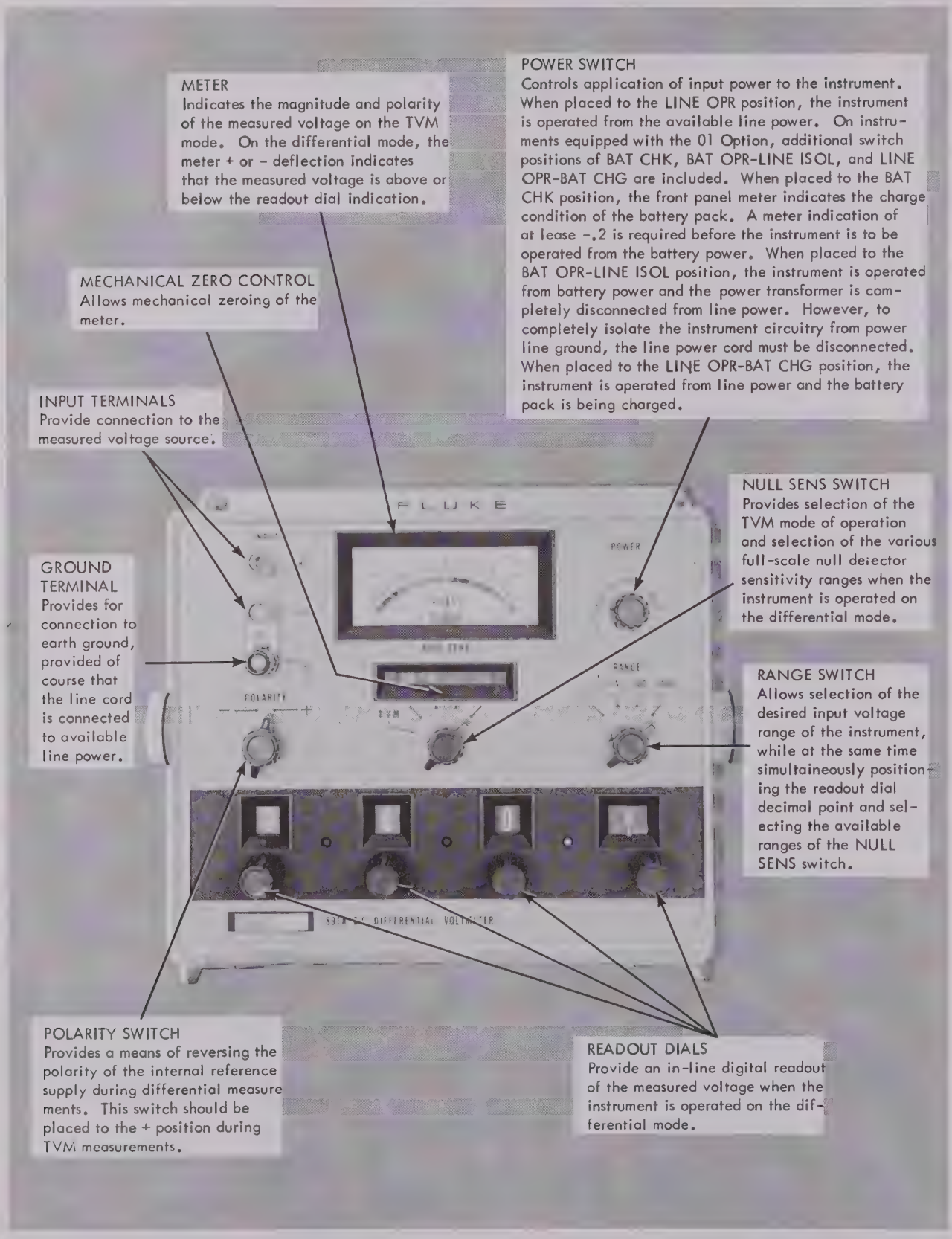

METER
Indicates the magnitude and polarity of the measured voltage on the TVM mode. On the differential mode, the meter + or - deflection indicates that the measured voltage is above or below the readout dial indication.
POWER SWITCH
Controls application of input power to the instrument. When placed to the LINE OPR position, the instrument is operated from the available line power. On instruments equipped with the 01 Option, additional switch positions of BAT CHK, BAT OPR-LINE ISOL, and LINE OPR-BAT CHG are included. When placed to the BAT CHK position, the front panel meter indicates the charge condition of the battery pack. A meter indication of at lease -.2 is required before the instrument is to be operated from the battery power. When placed to the BAT OPR-LINE ISOL position, the instrument is operated from battery power and the power transformer is completely disconnected from line power. However, to completely isolate the instrument circuitry from power line ground, the line power cord must be disconnected. When placed to the LINE OPR-BAT CHG position, the instrument is operated from line power and the battery pack is being charged.
MECHANICAL ZERO CONTROL
Allows mechanical zeroing of the meter.
INPUT TERMINALS
Provide connection to the measured voltage source.
NULL SENS SWITCH
Provides selection of the TVM mode of operation and selection of the various full-scale null deiector sensitivity ranges when the instrument is operated on the differential mode.
GROUND TERMINAL
Provides for connection to earth ground, provided of course that the line cord is connected to available line power.
RANGE SWITCH
Allows selection of the desired input voltage range of the instrument, while at the same time simultaineously positioning the readout dial decimal point and selecting the available ranges of the NULL SENS switch.
POLARITY SWITCH
Provides a means of reversing the polarity of the internal reference supply during differential measurements. This switch should be placed to the + position during TVM measurements.
READOUT DIALS
Provide an in-line digital readout of the measured voltage when the instrument is operated on the differential mode.
FLUKE
POWER
POLARITY
TVM
RANGE

Figure 2-1. THE MODEL 891A CONTROLS, TERMINALS, AND INDICATORS

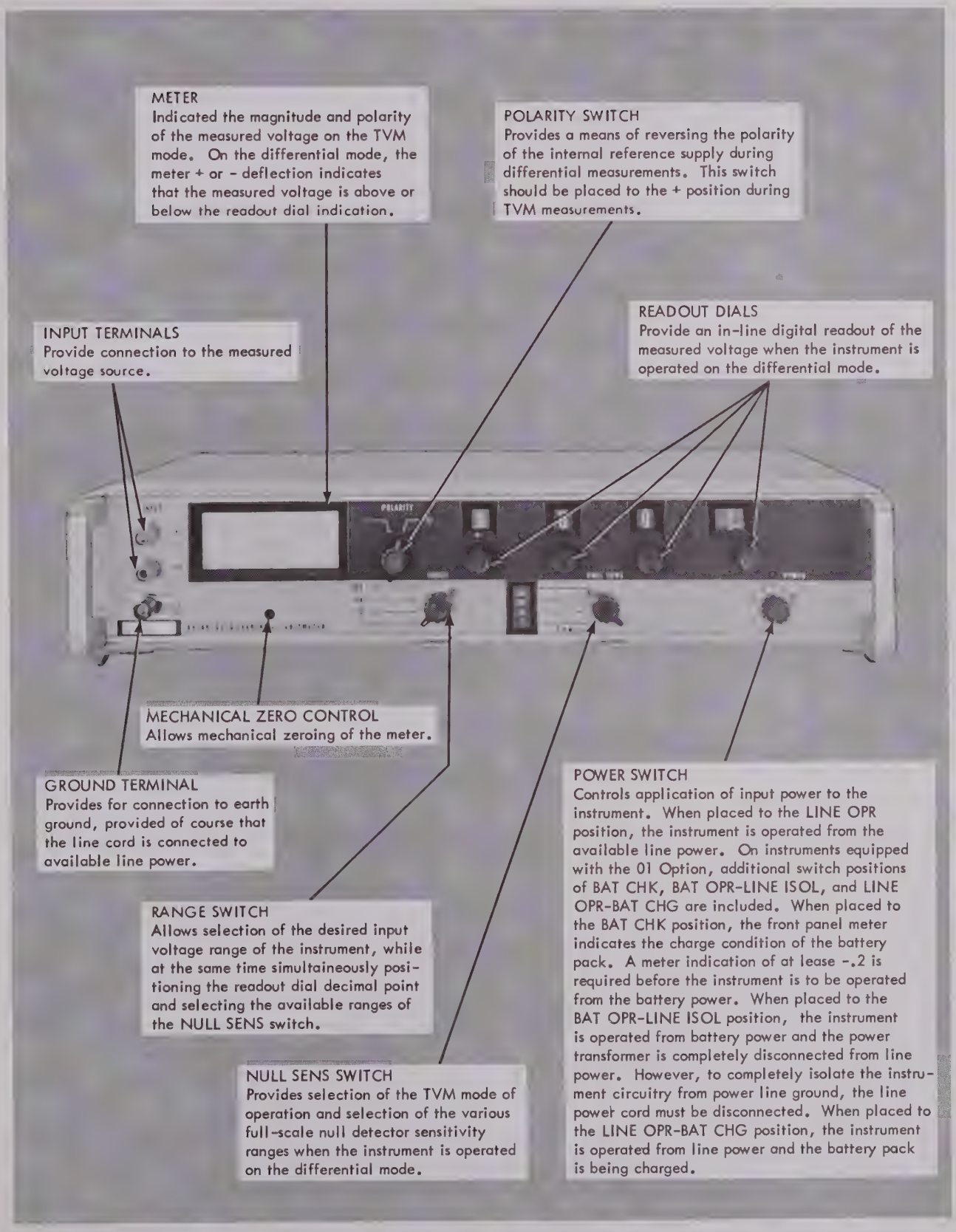

METER
Indicated the magnitude and polarity of the measured voltage on the TVM mode. On the differential mode, the meter + or - deflection indicates that the measured voltage is above or below the readout dial indication.
POLARITY SWITCH
Provides a means of reversing the polarity of the internal reference supply during differential measurements. This switch should be placed to the + position during TVM measurements.
INPUT TERMINALS
Provide connection to the measured voltage source.
READOUT DIALS
Provide an in-line digital readout of the measured voltage when the instrument is operated on the differential mode.
MECHANICAL ZERO CONTROL
Allows mechanical zeroing of the meter.
GROUND TERMINAL
Provides for connection to earth ground, provided of course that the line cord is connected to available line power.
RANGE SWITCH
Allows selection of the desired input voltage range of the instrument, while at the same time simultaneously positioning the readout dial decimal point and selecting the available ranges of the NULL SENS switch.
NULL SENS SWITCH
Provides selection of the TVM mode of operation and selection of the various full-scale null detector sensitivity ranges when the instrument is operated on the differential mode.
POWER SWITCH
Controls application of input power to the instrument. When placed to the LINE OPR position, the instrument is operated from the available line power. On instruments equipped with the 01 Option, additional switch positions of BAT CHK, BAT OPR-LINE ISOL, and LINE OPR-BAT CHG are included. When placed to the BAT CHK position, the front panel meter indicates the charge condition of the battery pack. A meter indication of at lease -.2 is required before the instrument is to be operated from the battery power. When placed to the BAT OPR-LINE ISOL position, the instrument is operated from battery power and the power transformer is completely disconnected from line power. However, to completely isolate the instrument circuitry from power line ground, the line power cord must be disconnected. When placed to the LINE OPR-BAT CHG position, the instrument is operated from line power and the battery pack is being charged.

Figure 2-2. THE MODEL 891AR CONTROLS, TERMINALS, AND INDICATORS

b. Touch the HI INPUT terminal and the chassis of the instrument with your hand, observing that the meter pointer deflects to the right or left.

c. Place the POLARITY switch to the - position and repeat step b. The meter pointer should deflect in the opposite direction by approximately the same amount observed in step b.

d. Remove the shorting strap from between the LO and ground INPUT terminals and connect the strap between the HI and LO INPUT terminals.

e. Perform the Readout dials versus NULL SENS checks of Figure 2-3, observing that the meter pointer indicates -1 for each particular check.

READOUT DIALS	NULL SENS
.000X	.001
.00100	.001
.01000	.01
.10000	.1

Figure 2-3. READOUT DIALS VERSUS NULL SENS CHECKS

f. Place the Readout dials, NULL SENS, and POLARITY switches to their respective .10000, .1, and + positions, observing that the meter pointer indicates -1.

g. Retaining the control positions of step f, place the RANGE switch to each available position observing that the meter pointer indicates -1 in all positions of the RANGE switch.

2-14. If the results of the Operational Test agree with information given, it can be assumed that the instrument is operating properly and measurements of dc voltages can now be performed.

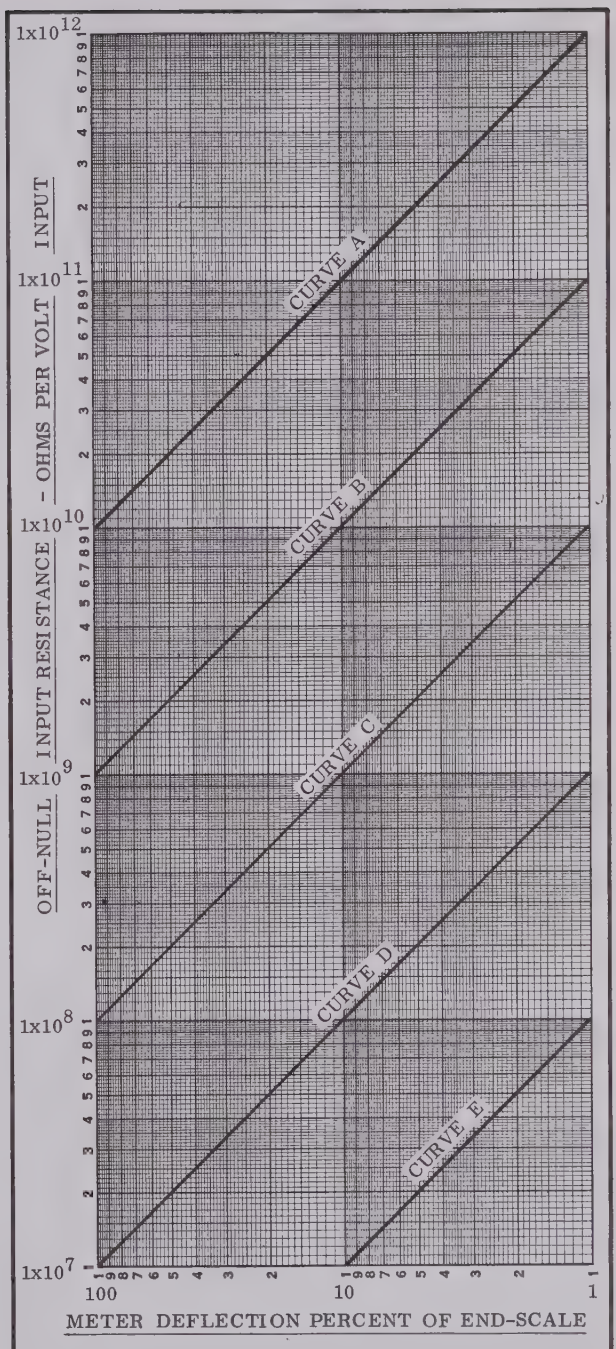
2-15. OPERATING NOTES

2-16. DIFFERENTIAL OFF-NULL INPUT RESISTANCE

2-17. Input resistance of the Model 891 is infinite at null, as no current flows between the measured source and the internal reference supply of the instrument. However, a small current does flow between the measured source and the internal reference supply whenever the instrument is not exactly nulled. For example, when the meter pointer is deflected 10% of full-scale on the .001 volt NULL SENS range, the input resistance of the instrument is 10^{11} ohms per volt of the measured input voltage or 10^{12} ohms for an input measured voltage of 10 volts dc. A graph of these apparent off-null input resistances is contained in Figure 2-4.

2-18. GROUND LOOP CURRENTS

2-19. A potential difference often exists between different points of power system grounds. Consequently, current may flow from one power system ground through the voltmeter and the voltage source being measured to another power system ground. These ground loop



RANGE	NULL SENS	CURVE	RANGE	NULL SENS	CURVE
1000	100	E	10	1	C
	10	D		.1	B
	1	C		.01	B
	.1	B		.001	A
100	10	D	1	.1	B
	1	C		.01	A
	.1	B		.001	A
	.01	B		.001	A

Figure 2-4. OFF-NULL INPUT RESISTANCES

currents should be avoided as they generate voltages that degrade measurement accuracy. To prevent these ground loop currents when the system being measured is grounded, remove the shorting strap between the LO INPUT terminal and the ground terminal or, if your instrument contains the -01 option, operate the BAT OPR/LINE ISOL position of the POWER switch.

2-20. USE OF SHORTING LINK

2-21. The ground INPUT terminal is directly connected to the chassis of the instrument. Consequently, whenever measurement of a voltage having a reference other than ground is performed, the shorting link between the LO INPUT terminal and the ground terminal must be removed.

2-22. DC COMMON MODE VOLTAGES

2-23. DC common mode measurement errors are caused partly by leakage currents through ground loops. Great care has been taken in the design and construction of this instrument to isolate the circuitry from chassis ground. Accurate dc measurements can be made with the Model 891 in the presence of common mode voltages of up to 500 volts dc. The dc common mode rejection is at least 120 db or one microvolt of error per common mode volt up to 70% relative humidity above 25° C. If the common mode voltage is greater than 50 volts, the measurement should be made several minutes after hookup for best accuracy due to the time required to charge the stray capacitance through the extremely high leakage resistance to ground.

2-24. OPERATION ON THE TVM MODE

2-25. The Model 891 can be used to make dc voltage measurements from ±10 microvolts to ±1,100 volts dc with an accuracy of ±3% of the selected range. To operate the instrument as a transistorized voltmeter (TVM), perform the operations described in the Preliminary Operating Procedures (paragraphs 2-9 and 2-10) and proceed as follows:

a. Connect the circuit to be measured between the HI and LO INPUT terminals. If one side of the voltage source being measured is grounded, connect the grounded side to the LO INPUT terminal.

b. Place the RANGE switch to the lowest voltage range possible while maintaining an on-scale meter pointer deflection. The meter pointer indication multiplied by the RANGE switch position is the value of the measured voltage. Left or right deflection of the meter pointer corresponds to a negative or positive polarity of the measured voltage, respectively.

c. Measurement of voltages from 0.02 millivolts to 0.1 volts dc is accomplished on respective NULL SENS positions of .001 through .1. In this application the RANGE switch is set to 1 and the Readout dials to .00000. The resulting meter indication multiplied by the NULL SENS switch position is the value of the measured voltage. Left or right deflection of the meter pointer corresponds to a negative or positive polarity of the measured voltage, respectively.

2-26. OPERATION AS A DIFFERENTIAL VOLTMETER

2-27. An improved accuracy of up to 250 times over that of the TVM mode is obtained when the instrument is operated as a dc differential voltmeter. To operate the instrument as a dc differential voltmeter, proceed as follows:

a. Determine the approximate value and polarity of the measured dc voltage by performing the TVM mode measurements described in paragraphs 2-25 and 2-26.

b. Place the POLARITY switch to the respective polarity observed in the TVM mode measurement and set the Readout dials to the TVM measurement value.

CAUTION!

Whenever the NULL SENS switch is placed to a position other than TVM, a voltage corresponding to the Readout dial indication appears between the LO and HI INPUT terminals. A personnel hazard does not exist as the source resistance is 90 megohms on the 100 and 1000 volt ranges. However, this potential can damage high input impedance semiconductor devices such as field effect transistors.

c. Place the NULL SENS switch to successively higher null sensitivity positions while adjusting the Readout dials to obtain a center-zero meter pointer indication.

d. The Readout dial digit indication directly corresponds to the magnitude of the measured dc voltage and the POLARITY switch position indicates the polarity of the measured voltage.

2-28. OPTIONAL RECORDER OPERATION

2-29. Instruments equipped with the -02 option provide an isolated recorder output voltage which is available at the rear panel terminals. The recorder output dc voltage is adjustable from zero to ±0.2 volts dc for a full-scale meter deflection and is used to drive a zero-center recorder. To utilize the recorder output, proceed as follows:

a. Connect the recorder to the rear panel RECORDER OUTPUT terminals.

Note!

The LO RECORDER OUTPUT terminal is connected to chassis ground. If a ground reference is undesirable, operate the Model 891 on battery power with its power cord disconnected from line power.

b. Turn the recorder on and place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	10

NULL SENS	1
POLARITY	+
Readout dials	1.00 00

c. Connect the shorting link between the front panel LO and HI INPUT terminals and adjust the RECORDER OUTPUT level control for the desired full-scale left indication on the recorder. The left full-scale meter excursion point on the recorder is now plotted and from this information the full-scale right point can be determined.

d. Remove the shorting link from between the LO and HI INPUT terminals and proceed with the desired measurement.

2-30. APPLICATIONS

2-31. The Model 891 DC Differential Voltmeter, because of its high input impedance and calibrated meter end-scale, can be used in many special applications. These applications, to mention a few are; measurement of voltage excursions about a nominal, measurement of extremely high resistances, and as a null detector. The following applications are general in nature and may be further expanded upon as you become more familiar with the use of your instrument.

2-32. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL

2-33. The instrument can be used to measure voltage excursions about a nominal value whenever the instrument is operated as a dc differential voltmeter. The meter end-scale is calibrated to be a known percentage of the Readout dial settings determined by the null sensitivity selected with the NULL SENS switch. For example, by selecting a null sensitivity of .1 with the NULL SENS switch on any voltage range, a full-scale left or right meter deflection represents ±1.1% of the Readout dial settings. To measure voltage excursions about a nominal, proceed as follows:

a. Perform the Preliminary Operating Procedures of paragraphs 2-9 and 2-10.

b. Determine the nominal value of the dc voltage being measured, using the TVM mode of the Model 891. Refer to paragraphs 2-24 and 2-25 for TVM mode operating procedures.

c. Place the Readout dials to the nominal value measured in step b and select the desired full-scale meter sensitivity with the NULL SENS switch.

d. The voltage excursions about the Readout dial digit indication can now be determined by the left or right meter deflection.

2-34. OPERATION AS A NULL DETECTOR

2-35. The Model 891, because of its high input impedance on the differential mode, can be used to monitor small voltage differences in bridge circuits, potentiometers, and other measuring devices. In most of these applications the circuits are adjusted for zero deflection or a null on the Model 891. Equipment connections for two types of null detector configurations are illustrated in Figure 2-5 and 2-6. To operate the instrument as a null detector, perform the preliminary operating procedures described in paragraphs 2-9 and 2-10 and proceed as follows:

a. Select the desired equipment application as illustrated in Figure 2-5 and 2-6 and make the appropriate equipment connections.

b. Place the Model 891 NULL SENS switch to the desired null detector sensitivity and adjust the circuit being measured for a zero or null deflection on the Model 891 meter.

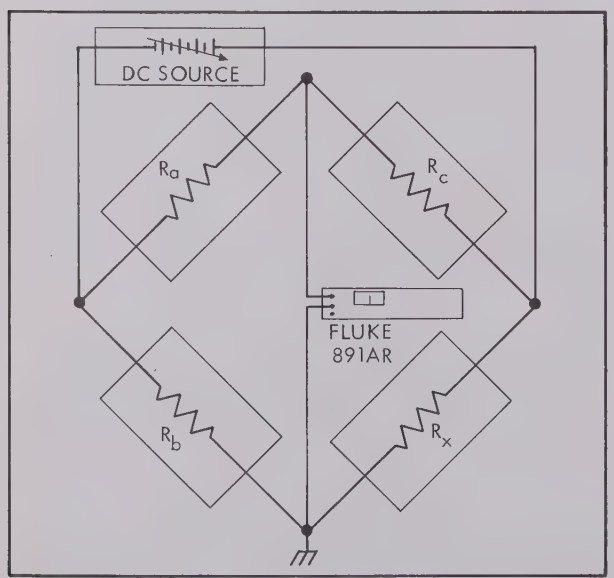


Figure 2-5. BRIDGE DETECTOR-FLOATING SUPPLY

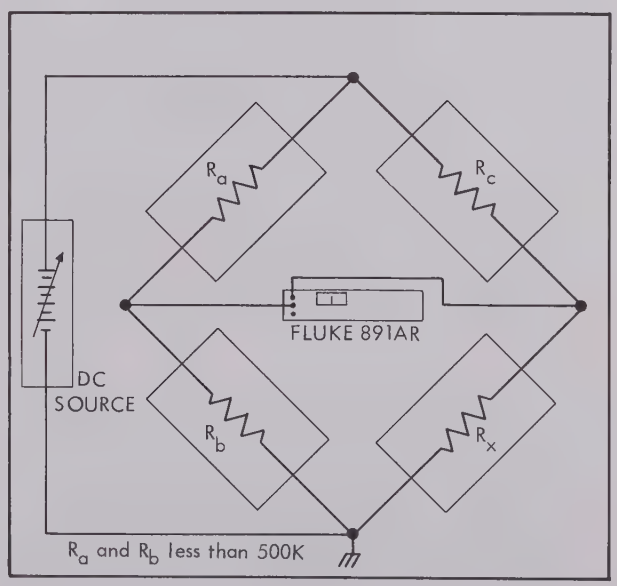


Figure 2-6. BRIDGE DETECTOR-FLOATING NULL DETECTOR

2-36. MEASUREMENT OF HIGH RESISTANCES

2-37. The Model 891 can be used as a megohmmeter for rapid measurements of high resistance from 10 to 10^6 megohms with a typical accuracy of ±5%. To measure high values of resistance, perform the preliminary operating procedures described in paragraph 2-9 and 2-10 and proceed as follows:

a. Place the RANGE switch to 10 and the NULL SENS switch to .01. If the estimated value of the resistance to be measured is more than 10^{10} ohms, place the NULL SENS switch to .001.

b. Connect the unknown resistance between the LO and HI INPUT terminals. Use short isolated leads to prevent measuring the leakage resistance between the leads.

c. Rotate the Readout dials to obtain a meter deflection of -1 and use the following calculations to determine the value of the unknown resistance.

$$R_x = \left(\frac{E_{ro}}{E_m} - 1\right) R_{nd}$$

R_x = Unknown resistance

R_{nd} = Null detector input resistance of 10 megohms for NULL SENS settings of .01 and .001 and 100 megohms on all other settings.

E_{ro} = Readout dial voltage

E_m = Meter deflection in volts (proportional to selected NULL SENS)

2-38. OVERLOAD PROTECTION

2-39. The Model 891 input circuitry is designed to withstand up to a 1,200 volt input on any voltage range. Should the instrument be subjected to prolonged voltage overloads, excessive dissipation in the protective devices will result which cause generation of thermal voltages. These thermal voltages will take several minutes to subside after the overload is removed.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The theory of operation for the Model 891 DC Differential Voltmeter is contained in this section of the manual. A block diagram analysis is used to functionally describe the overall instrument operation followed by a detailed circuit description of each particular block section. A block diagram of the instrument is illustrated in Figure 3-1 and the schematic diagram is located at the rear of the manual.

3-3. OVERALL BLOCK DIAGRAM ANALYSIS

3-4. INTRODUCTION

3-5. The Model 891 circuitry is composed of a 1.1, 11, 110 and 1100 VDC reference supply, a Kelvin-Varley divider, an input divider, a null detector, a meter, and an optional recorder output. These circuits are interconnected by various switching arrangements when performing the desired conventional (TVM) or differential (NULL) dc voltage measurements.

3-6. CONVENTIONAL (TVM) VOLTMETER MODE

3-7. When the instrument is used as a conventional voltmeter (TVM), the instrument circuitry is connected as illustrated in Figure 3-1. The input divider is connected across the input terminals of the instrument, providing a constant 100 Megohm input impedance on all ranges. With a full-scale input voltage applied to the input terminals of the instrument, the selected tap of the input divider provides an input voltage of ±1.0 millivolt dc to the input of the null detector which drives the front-panel meter. The gain of the null detector is precisely controlled by negative feedback to produce a full-scale meter deflection for any full-scale input voltage applied to the instrument. For positive or negative voltage measurements in the TVM mode, the POLARITY switch should be in the positive (+) position,

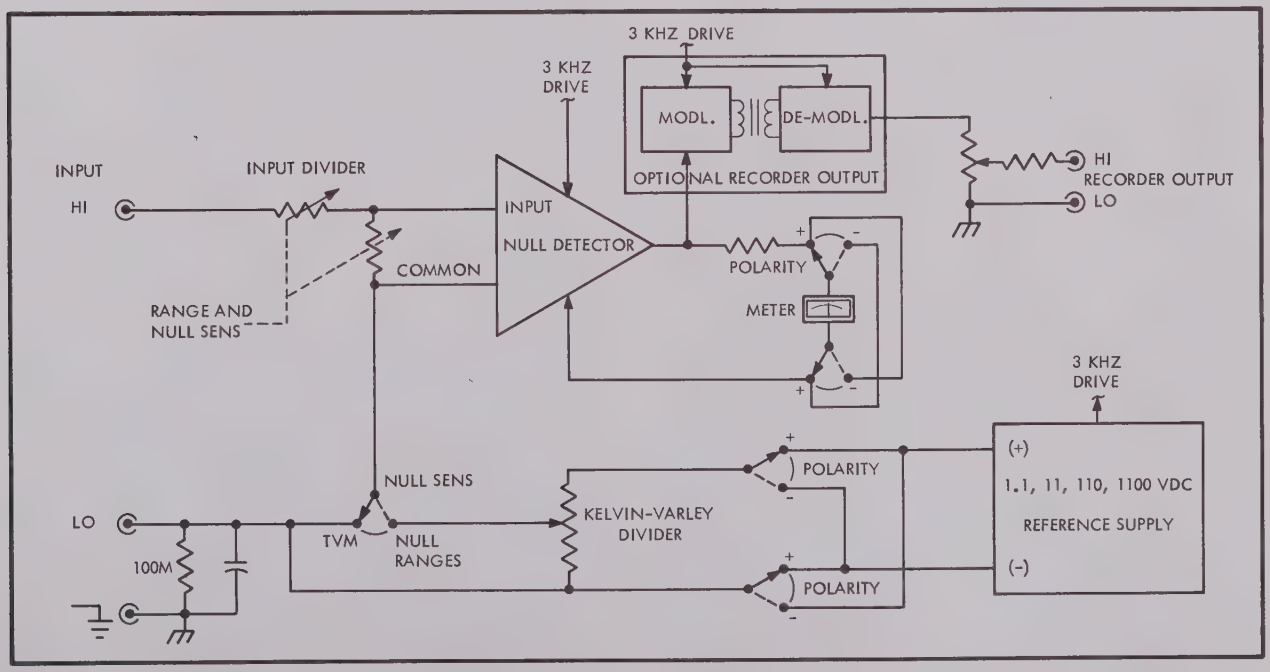


Figure 3-1. MODEL 891A/AR BLOCK DIAGRAM

thus allowing the panel meter to indicate the magnitude and polarity of the measured voltage.

3-8. DIFFERENTIAL (NULL) VOLTMETER MODE

3-9. By placing the NULL SENS switches of Figure 3-1 to the NULL RANGES position, the instrument circuitry is connected as a dc differential voltmeter. In this mode of operation the NULL SENS switch selects a suitable resistance value from the input divider resistors that determines the instrument full-scale sensitivity and applies the output of the Kelvin-Varley divider to the common input of the null detector. The dc input voltage applied to the instrument is then compared to the Kelvin-Varley divider output voltage by the null detector and any resulting difference used to drive the zero-center meter. Any + right or - left meter deflection corresponds to an input voltage below or above the Kelvin-Varley divider output voltage, respectively. For positive or negative voltage measurements, the meter terminals and Kelvin-Varley divider input voltage polarity can be reversed through the contacts of the POLARITY switch.

3-10. RECORDER OUTPUT

3-11. The optional recorder output provides isolation between the null detector output and the recorder output. The null detector output voltage is modulated by a 3 kHz drive signal derived from the reference supply. The resulting signal is then transformer coupled to the demodulator which is driven at the same 3 kHz rate. The resulting synchronously demodulated dc voltage is applied through a variable resistor to the recorder output terminals. The variable resistor provides adjustment of the full-scale recorder output level.

3-12. INDIVIDUAL CIRCUIT DESCRIPTION

3-13. INTRODUCTION

3-14. The circuitry of the Model 891 is composed of a power supply/battery charger, a reference supply comprised of a reference amplifier and a reference inverter, a null detector, a Kelvin-Varley divider, an optional recorder output, a meter, input divider resistors, a RANGE switch, a NULL SENS switch, a POLARITY switch, and a POWER switch. These circuits will be described in detail using simplified circuit diagrams and the functional schematic diagram.

3-15. POWER SUPPLY/BATTERY CHARGER

3-16. The input power transformer T1 receives 115 or 230 volts ac through the contacts of the POWER switch S2BR-1 and S2BR-2. The primary winding of T1 is constructed in such a manner as to allow the instrument to be operated from 115 volts ac, windings in parallel, or 230 volts ac, windings in series. Switch S5 provides the desired 115/230 volt ac power connections. Fuse F1 protects the instruments circuitry from overloads. The secondary winding of T1 has four taps which supply ac voltages to the instrument's power supply and battery charger. The ac voltages present at pins 8 and 10 are full-wave rectified by diodes CR1, CR2, and the capacitors C1 and C2 located in the A2 Reference Amplifier Assembly.

3-17. On the Model 891 -01 version instruments, the ac voltage present at pins 9 and 11 of T1 is full-wave rectified by diodes CR3 and CR4 and applied across R9 and BT1. When the POWER switch S2 is placed to the BAT CHG position, the contacts of S2BF bypass resistor R9 providing maximum charging current to the rechargeable battery pack of BT1. The lamp DS1 functions as a ballast, limiting the charge current to the optimum value for rapid charging. Resistor R9 is unbypassed in all other positions of S2BF, providing a trickle-charge for the battery pack in the LIN OPR position of the POWER switch. Checking of the battery pack voltage level is obtained when the POWER switch S2 is placed to the BAT CHK position. Switches S2BR-1, S2BR-2, S2BF, S2AF, and S2AR provide the necessary switching action, removing any ac input voltage and placing the meter M1 in series with A2R4. The meter and A2R4 are then in parallel with the series-pass transistor A2Q2, thus providing a check of the battery pack under the actual operating load condition.

3-18. THE REFERENCE SUPPLY

3-19. GENERAL. Reference voltages of 1.1, 11, 110, and 1100 volts dc, upon which the stability of the instrument relies, and a 3 kHz output signal are produced by the Reference Supply. The circuitry of the Reference Supply consists of two regulator stages and a dc-dc converter. A block diagram of these circuits is illustrated in Figure 3-2.

3-20. BLOCK DIAGRAM DESCRIPTION. The dc to dc converter regulator provides a pre-regulated voltage to the zener current regulator and a regulated voltage to the dc to dc converter. The zener current regulator provides a closely regulated dc current for the reference zener diodes of CR3 and CR4 from which the 1.1 and 11 volt dc reference voltages are derived. These same zener diodes also provide a stable reference voltage for the dc to dc converter comparison amplifier. The dc to dc converter produces the 110 and 1100 volt dc reference voltages and a 3 kHz drive signal. The reference divider junction provides a sample of the 110 and 1100 volt dc reference voltage to the dc to dc converter comparison amplifier which controls the input dc voltage to the dc to dc converter. Consequently, a stable 110 or 1100 volt dc reference voltage related to the zener reference voltage is obtained. The 3 kHz drive signal is used to produce operating voltages for the null detector and optional recorder output circuits.

3-21. CIRCUIT DESCRIPTION. The unregulated dc voltage from the power supply or the dc output voltage of the battery pack is applied to terminal 3 of the Reference Amplifier Assembly. This voltage is used to provide an input dc voltage to the dc to dc converter regulator circuitry. Initial turn-on of the dc to dc converter regulator circuitry is accomplished with the circuitry comprised of A2R1, CR1, CR2, CR5 and Q4. The voltage developed at the junction of R1 and CR5 forward biases CR1 and transistor Q4. Conduction of Q4 is initially through the low impedance path of CR2, thus providing a dc input voltage to the zener current regulator. The resulting zener reference voltage biases the comparison amplifier circuitry of Q3, Q5, and Q6 into conduction. As the dc to dc converter regulator

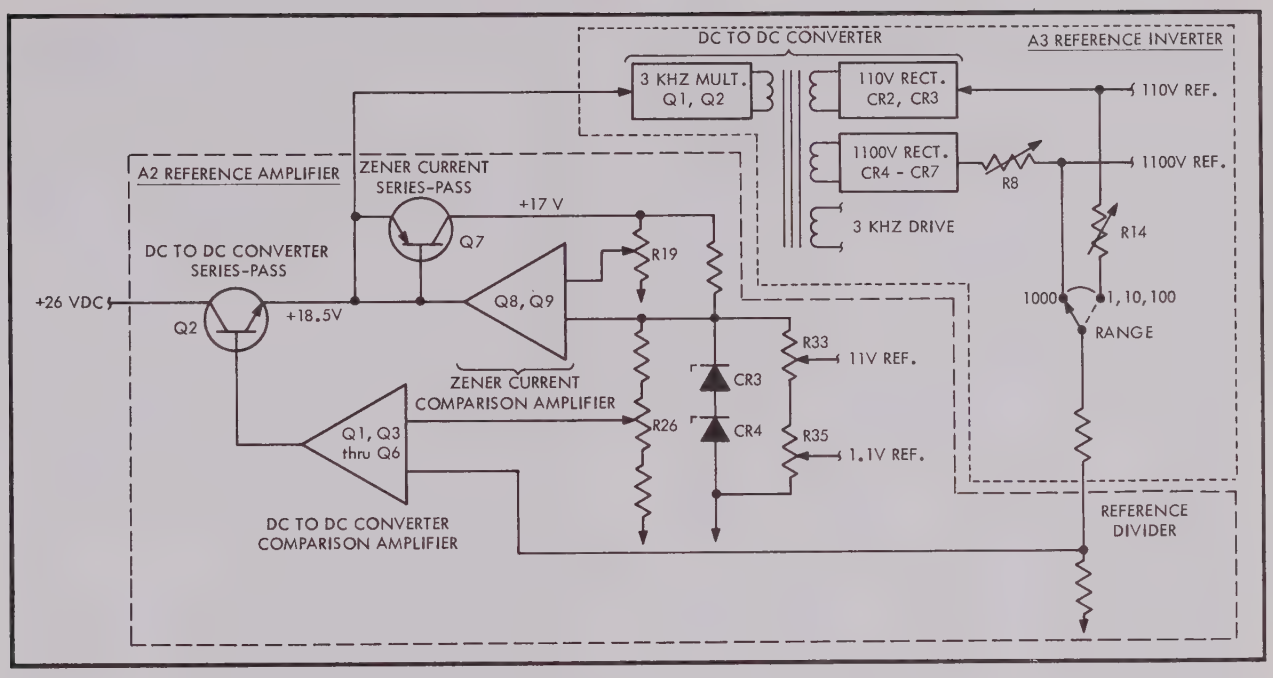


Figure 3-2. REFERENCE AMPLIFIER/REFERENCE INVERTER - SIMPLIFIED

output approaches the nominal +18.5 volt dc level, diodes CR1 and CR2 are reversed biased, disconnecting the turn-on circuitry from the regulator circuitry. Transistor Q4 then functions as a buffer amplifier between the series-pass driver Q1 and the comparison amplifier output from Q5.

3-22. The zener current regulator circuitry is composed of transistors Q7 through Q9, zener diodes CR3 and CR4 and associated resistors. Transistor Q7 is the series-pass element while resistor R13 provides starting current to initially turn-on the reference elements of CR3 and CR4. The resistive network of R17 through R19 form a divider across the output of the zener current regulator and provides a sample of its output voltage to the base of Q9. Resistor R19 provides adjustment of the output voltage of the zener current regulator. Transistors Q8 and Q9 comprise a differentially connected comparison amplifier with the zener voltage of CR3 and CR4 providing a reference at the base of Q8. This reference voltage has a very low temperature coefficient from which the instrument derives its measurement stability. The output of the differential connected comparison amplifier controls the conduction of the series-pass transistor Q7 and determines the output voltage of the zener current regulator. This output voltage establishes a fixed current through the zener diodes of CR3 and CR4. Two resistive dividers comprised of R26 through R31 and R32 through R36 are connected across the zener diodes of CR3 and CR4. The divider composed of R26 through R31 is used to provide a reference voltage to the dc to dc converter comparison amplifier Q3. The divider composed of R32 through R36 is used to produce the 1.1 and 11 volt dc reference voltage applied to the Kelvin-Varley divider on the 1 and 10 volt ranges of the instrument. Variable resistor R26 provides adjustment of the dc to dc converter regulator output voltage while R33 and R35 provide adjustment of the 1.1 and 11 volt dc reference voltages.

3-23. The dc to dc converter regulator circuitry is comprised of transistors Q1 through Q6 and associated resistors and capacitors. Transistor Q2 is the series-pass element whose conduction is controlled by the series-pass driver Q1 and the two differentially connected comparison amplifiers of Q3, Q5 and Q6. Transistor Q3 receives a reference voltage through R25 from the previously described zener current regulator. A sample of the Reference Inverter Assembly dc output voltage present at terminal 8 is developed across R21 and R22 and applied to the other base Q3. Transistor Q3 compares the sample of the Reference Inverter Assembly output voltage to the zener reference voltage and amplifies any resulting difference. Transistors Q5 and Q6 comprise the second stage of the comparison amplifier and amplify any resulting voltage difference detected by Q3. The output of Q5 is applied to the series-pass driver Q1 through the common-base buffer Q4. The series-pass driver controls the base current of Q2 which in turn determines the output voltage of the dc to dc converter regulator and consequently, any resulting output voltage of the Reference Inverter Assembly.

3-24. The output voltage of the dc to dc converter regulator is applied to terminal 3 of the Reference Inverter Assembly. This voltage is used to provide operating voltages for the 3 kHz transformer coupled multivibrator composed of Q1, Q2 and T1. A low-pass filter comprised of R1, C1 and C2 provides decoupling of any 3 kHz variations that could be applied back to the reg-

ulator circuitry. Resistor R2 provides the dc current to the bases of Q1 and Q2 necessary to initially start the multivibrator. Diode CR1 functions as a clamper and capacitor C1 bypasses CR1 to provide a low resistance source to the bases of Q1 and Q2. Upon application of an input dc voltage, assuming that Q1 will conduct harder than Q2, the collector of Q1 clamps the upper end of the center-tapped winding of T1 to zero volts dc. The base-drive winding associated with R3 applies a positive going signal to the base of Q1, driving the transistor into saturation. The lower end of the center-tapped winding is driven to +36 volts dc by autotransformer action causing the base-drive winding associated with R4 to apply a negative going signal to the base of Q2 cutting-off the transistor. This condition will persist for a period proportional to the flux capacity of the transformer core, which in this case is approximately 150 microseconds. At the end of this period, the voltages across the transformer windings are reversed by the collapsing lines of flux, driving transistor Q1 into cut-off and Q2 into saturation, thus establishing the second half-cycle of the 3 kHz signal. The resulting 3 kHz signal is then coupled to the secondary of T1 where it is used to provide drive signals and the 110 and 1100 dc reference voltages. Variable resistor R5 provides a means of reducing any capacitive coupling effects to the winding in the shield of T1.

3-25. The secondary signals of T1 that are available at terminals 6 through 10 of the Reference Inverter Assembly are used to provide drive signals to the Null Detector and optional Recorder Output circuitry. Two full-wave voltage doublers in the remaining secondary windings of T1 product the 110 and 1100 volt dc reference voltages used by the Kelvin-Varley divider. These voltages are used on the 100 and 10000 voltage ranges of the instrument. The full-wave voltage doubler composed of CR3, CR4, R6 and C4 through C6 produces the 110 dc reference voltage available at terminal 2 of the Reference Inverter Assembly. Resistor R14 provides adjustment of this reference voltage. The full-wave voltage doubler composed of CR4 through CR7, R7 through R11 and C7 through C9 produces the 1100 volt dc reference voltage available at terminal 1 of the Reference Inverter Assembly. Resistor A2R26 provides adjustment of the resulting input voltage. A resistive divider comprised of R9 through R11 provides a load for the voltage doubler when this reference voltage is not being used and functions as a bleeder when power is removed from the circuit. Regulation of the 110 and 1100 volt dc reference voltage is accomplished by feeding a sample of the selected reference voltage back to the dc to dc converter regulator circuitry. Switches S1AR-1 and S1AR-2 select the desired sections of a resistive divider composed of R12 through R16 and the resistors R21 and R22 located in the Reference Amplifier Assembly. This sample of the output reference voltage controls the level of the input voltage applied to the 3 kHz multivibrator which determines the level of the secondary voltages of T1 and in turn controls the output level of the full-wave voltage doublers used to develop the 110 and 1100 volt dc reference voltages.

3-26. KELVIN-VARLEY DIVIDER

3-27. GENERAL. Continuous division of the reference supply voltages, while presenting a constant load to the reference supply, is accomplished with a Kelvin-Varley divider. The divider is composed of matched fixed resistors R1 through R34, trimmers R35 and R36, potentiometer R37 and rotary switches S6 through S8.

3-28. CIRCUIT DESCRIPTION. Rotary switch S6 controls the first order division of the reference supply voltage. The first resistive divider of R1 through R12 is arranged in 12 equal parts of 100K ohms. The contacts of S6 connect the 200K ohm effective resistance of the second divider in parallel with the selected two parts of the first divider, thus producing a selected resistance value of 100K ohms. This selected resistance value is in series with the remaining ten 100K ohm parts of the first divider and presents a constant load resistance of 1.1M ohms to the reference supply. There are eleven equal voltage steps available from the first divider which can be selected by the rotary switch S6. Since the reference supply output voltage is either 1.1, 11, 110, or 1,100 volts dc, the rotary switch S6 is calibrated in 0.1, 1, 10, or 100 volt increments.

3-29. The second, third, and fourth order divisions of the reference supply voltage are provided by the corresponding resistive dividers R13 through R23, R24 through R34, and potentiometer R37. The second and third order dividers function in a manner similar to the first order divider with their associated switches S7 and S8 performing the desired connections. Each of these dividers are composed of 11 equal value resistors, thus providing ten equal divisions of the preceding divider output voltage. Potentiometer R37 comprises the fourth order divider which operates on the same principle as the preceding dividers but provides a continuously variable output voltage at its wiper. Resistors R35 and R36 provide the necessary trimming resistance for the fourth order divider.

3-30. The voltage appearing at the wiper of R37 is the output voltage of the Kelvin-Varley divider. This voltage directly corresponds to the readout dials digit value for the particular reference supply voltage being used. The RANGE switch S1AF2 selects the appropriate reference supply voltage of 1.1, 11, 110, or 1100 volts dc corresponding to the 1, 10, 100, or 1000 volt ranges of the instrument. The NULL switch S3AF applies the Kelvin-Varley output voltage to the null detector common on the various null ranges of the instrument. Whenever the instrument is operated on the TVM mode, S3AF disconnects the output of the Kelvin-Varley divider from null detector common and connects the low input common to null detector common. Reversal of the Kelvin-Varley output voltage polarity is provided by the POLARITY switches S4AF1 and S4AF2.

3-31. NULL DETECTOR

3-32. GENERAL. The Null Detector is a chopper stabilized dc amplifier using an insulated field effect transistor as a chopper. DC operating voltages for the amplifier are produced from a 3 kHz drive signal supplied by the dc-to-dc converter, thus providing maximum isolation for the amplifier circuitry free from power line frequency variations and harmonics. Circuitry of the Null Detector consists of a power supply, an 84 Hz multivibrator, a chopper driver, a chopper, a low-

pass filter, a carrier amplifier, a synchronous demodulator and a meter. A block diagram of these circuits is illustrated in Figure 3-3.

3-33. BLOCK DIAGRAM DESCRIPTION. All operating voltages for the Null Detector circuitry are provided by the power supply comprised of half-wave rectifiers CR3 and CR4. These ±6.8 volt dc voltages are produced from a 3 kHz drive signal developed in the Reference Inverter. The 84 Hz multivibrator provides chopper and demodulator drive voltages at a rate asynchronous to the power line frequency. Input dc voltages applied to the null detector input are passed through a low-pass filter to reduce any normal mode interference and then squarewave modulated at an 84 Hz rate by the chopper Q1. The chopper driver Q11 provides an 84 Hz drive signal to the gate of the chopper and a cancellation signal to the drain. This cancellation signal is 180° out of phase with the chopper gate signal and provides cancellation of any spikes generated internally in the chopper Q1. The carrier amplifier amplifies the resulting ac signal which, when the instrument is operated on the TVM mode, is proportional to the difference between any feedback voltage from the meter circuit at the source of the chopper and the null detector input voltage. When the instrument is operated in the NULL mode, the null detector common is driven at the output level of the Kelvin-Varley divider causing the resulting ac signal applied to the carrier amplifier to be proportional to the difference between the null detector input voltage and the Kelvin-Varley output level. The carrier amplifier is comprised of five amplifier stages whose gain is controlled by negative emitter feedback. Any amplified ac signals are then demodulated by the synchronous demodulator Q8 which is driven in synchronism with the chopper Q1. The resulting dc voltage is then used to drive the front-panel meter to indicate both the polarity and magnitude of the input voltage on the TVM mode or the off-null magnitude of the NULL mode.

3-34. CIRCUIT DESCRIPTION. The 3 kHz drive signal applied to terminal 8 of the Null Detector Assembly is half-wave rectified to provide ±6.8 volt dc operating voltages for the null detector circuitry. Diodes CR3 and CR4 along with C17 through C19 and R33 and R34 form the half-wave rectifiers used to produce the dc operating voltages. Synchronous drive voltages for the null detector circuitry are provided by the 84 Hz collector-coupled multivibrator comprised of Q9, Q10, C14, C14 and R23 through R26. The 84 Hz collector signal of Q9 is used to provide the demodulator drive for Q8. Transistor Q11 supplies an 84 Hz squarewave from its emitter to the gate of Q1. This signal is derived from the collector of Q10 in the 84 Hz multivibrator. Resistor R27 provides adjustment of the squarewave signal amplitude applied to the gate of Q1. The collector signal of Q11 is coupled by C5 and C4 to the output of Q1 where it is used to null out any spikes internally generated in Q1. Adjustment of this compensating signal is provided by potentiometer R31 located in the collector circuit of Q11.

3-35. The resulting squarewave signal present at the junction of R3 and Q1 is coupled by C3 to the input stage of the carrier amplifier. This signal, when the instrument is operated on the TVM or differential mode, is proportional to the difference between any feedback voltage from the meter circuit and the input voltage at terminal 2. The carrier amplifier is comprised of four common-emitter amplifiers of Q2 through Q5 and complimentary push-pull output amplifier of Q6 and Q7. Negative emitter feedback through the network composed

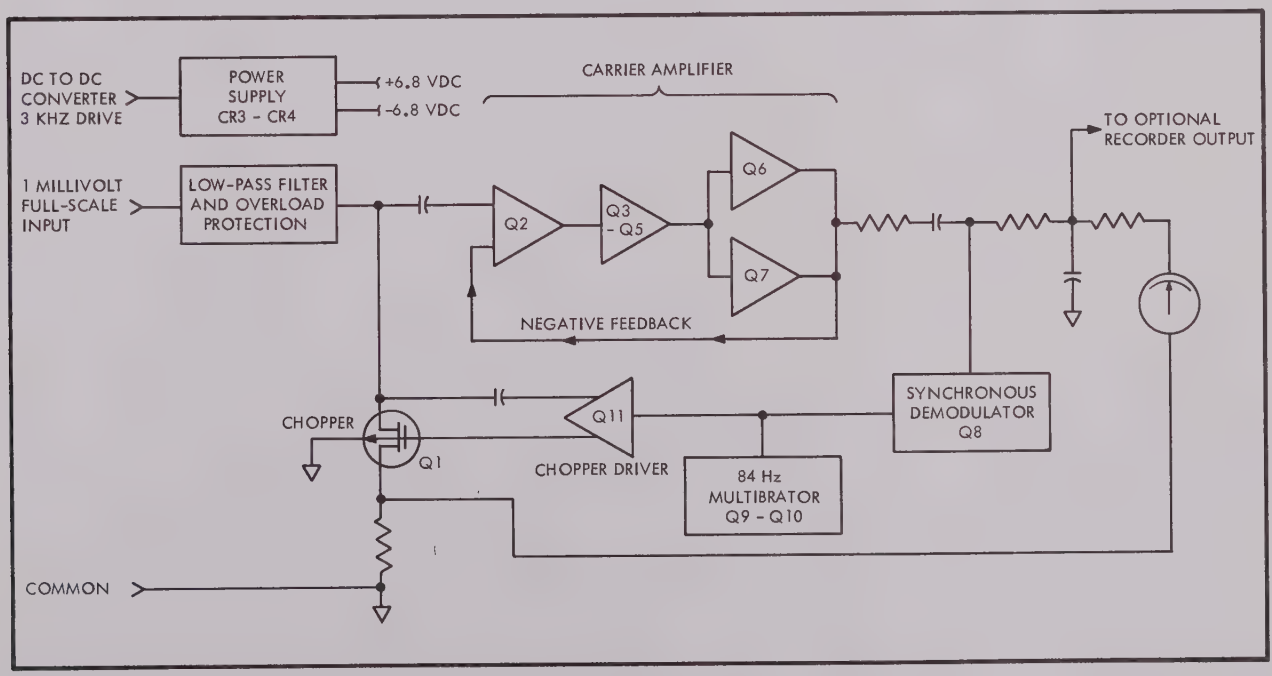


Figure 3-3. NULL DETECTOR BLOCK DIAGRAM

of R10 and R15 through R18, C8 and C11 controls the gain of the carrier amplifier and consequently the overall sensitivity of the null detector. Variable resistor R17 located in the feedback circuit provides adjustment of this sensitivity. The emitter signal of Q6 and Q7 is coupled by C12 and R20 to the synchronous demodulator Q8. Transistor Q8 is driven in synchronism with the chopper Q1 and is operated in the inverse mode to secure minimum saturation voltage. The resulting demodulated signal is filtered by the low-pass filter comprised of R21 and C13 and applied to terminal 5 for use in the optional Recorder Output circuitry. This same voltage signal is applied through R22 and the meter circuit to Q1 as a negative feedback signal to control the gain of the null detector. Any current flow through this network causes a corresponding deflection on the meter proportional to the magnitude and polarity or off-null value of the measured voltage.

3-36. INPUT DIVIDER

3-37. GENERAL. Full-scale input voltages to the instrument on either mode of operation are reduced to one millivolt (±10% overranging) at the input of the null detector by the Input Divider circuitry.

3-38. CIRCUIT DESCRITION. The Input Divider is composed of seven series connected resistors R1 through R7 that have a total resistance of 100.1 megohms. When the instrument is operated in the TVM mode, the input impedance is a constant 100 megohms on all voltage ranges and the RANGE switch is used to select the desired tap of the divider network. When the instrument is operated on the differential mode, the NULL and RANGE switches select various taps on the input divider network to provide an input impedance of 10 megohms on the .001 and .01 NULL switch positions, and 100 megohms on all other NULL switch positions.

3-39. OPTIONAL RECORDER OUTPUT

3-40. GENERAL. Instruments containing the -02 option are provided with a RECORDER OUTPUT that is isolated from the null detector circuitry. The Recorder Output circuitry is composed of two push-pull complementary stages driven at a 3 kHz rate, thus providing modulation and demodulation of the input dc voltage from the null detector.

3-41. CIRCUIT DESCRIPTION. Operating voltages for the complementary push-pull amplifier comprised of Q1, Q2, R1, R2, and the primary of T1 are provided from the Reference Inverter Assembly at a 3 kHz rate. Consequently, the dc input voltage applied to terminal 1 of the Recorder Output from the Null Detector Assembly is modulated at a 3 kHz rate. The resulting modulated signal is coupled to the secondary of T1 where demodulation occurs. Operating voltages for the complimentary push-pull amplifier comprised of Q3, Q4, R3, R4, and the secondary of T1 are also provided from the Reference Inverter Assembly at a 3 kHz rate. Demodulation of the 3 kHz secondary signal of T1 is provided with this amplifier stage and the resulting dc component filtered by C1 and R10. Variable resistor R10 provides adjustment of the RECORDER OUTPUT level.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. This section of the manual contains the information necessary for you to maintain your Model 891 DC Differential Voltmeter. The information is arranged under headings of "SERVICE INFORMATION, DISASSEMBLY INSTRUCTIONS, GENERAL MAINTENANCE, PRECALIBRATION AND TROUBLESHOOTING, and CALIBRATION PROCEDURES." A list of the test equipment required for maintenance of this instrument is contained in Figure 4-1. If the recommended test equipment is not available, other instruments having the equivalent specifications may be substituted.

4-3. Your instrument was completely tested and aligned before leaving the factory and calibration should not be necessary during the first year of operation. However, should you wish to check the instrument accuracy against most of the specifications contained in Section I, the information contained in the Calibration Procedures may be used. The Calibration Procedures are arranged in such a manner that by disregarding the adjustment information they may be used as Instrument Performance Checks.

4-4. We recommend that you thoroughly read and understand this section of the manual before attempting any maintenance on your instrument.

4-5. SERVICE INFORMATION

4-6. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. Complete warranty information is contained in the Warranty page located at the rear of this manual.

4-7. Factory authorized calibration and repair service for all Fluke instruments are available at various world wide locations. A complete list of factory authorized service centers is located at the rear of this manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments beyond the warranty period.

EQUIPMENT NOMENCLATURE	SPECIFICATIONS	RECOMMENDED INSTRUMENT
DC Voltage Calibrator	0 - 1000 volts dc with an accuracy of 0.002%	Fluke Model 332B
Oscilloscope	Sweep range: 50 usec/cm Vertical sensitivity: 5 mv/cm	Tektronix 531 with Type L Plug-In Unit
Probe	Passive 100:1	P6007
Multimeter	Ranges: AC - 0 to 100 MA 0 to 300 VAC DC - 0 to 100 MA 0 to 1000 VDC Resistance - 0 to 100 Megohms Accuracy: AC ±1% DC ±0.1%	Fluke Model 853A
Autotransformer	0 - 130 VAC at up to 3 amperes	General Radio Model W5MT
Differential Voltmeter	Range: 0 to 1000 VDC with an accuracy of ±0.06% Input impedance - Infinite at null	Fluke Model 895A
Resistor	10 Megohms ±1%	

Figure 4-1. REQUIRED TEST EQUIPMENT

4-8. MAINTENANCE ACCESS

4-9. THE MODEL 891A DISASSEMBLY INSTRUCTIONS

4-10. The following procedure is to be used to gain access to various parts of the Model 891A:

a. Remove the eight top dust cover attaching screws and remove the dust cover from the instrument.

b. Remove the two screws from the circuit board retaining strap located across the center of the instrument and remove the strap. This allows access to the Null Detector, Reference Amplifier and Reference Inverter printed circuit boards and NULL SENS switch S3.

c. Remove the top front and rear trim strip attaching screws and remove the trim strips from the instrument. This allows access to the front panel binding posts, components on the POWER switch S2, and (if the -01 option is installed) DS1.

Note!

The printed circuit boards are inserted in slide holders and will protrude approximately three inches when the instrument is to be inverted, place a strip of masking tape across the chassis of the instrument to hold the printed circuit boards in place.

d. Remove the eight lower dust cover attaching screws and remove the dust cover from the instrument. This allows access to the Kelvin-Varley Divider Assembly.

e. Remove the lower front and rear trim strip attaching screws and remove the trim strips from the instrument. This allows access to Kelvin-Varley switches S6 through S8 and potentiometer R37.

f. Remove the left and right knurled knobs from the handle assembly and remove the handle from the instrument.

g. Remove the eight left and right rear panel attaching screws and slide the rear panel free from the instrument. This allows access to the power transformer T1, CR1, CR2 and any option components.

h. Loosen the front panel control knob allen set screws and remove the knobs from the front panel. Loosen the two screws securing the shutter cabling to the front panel and then remove the nuts on the front panel binding posts and remove the terminal clips from the binding posts. Remove the left and right front panel attaching screws and slide the front panel forward until free of the instrument. This allows access to the front panel meter and all switch linkages.

i. Remove the right side panel attaching screws and remove the panel from the instrument. This allows access to the RANGE switch S1.

4-11. THE MODEL 891AR DISASSEMBLY INSTRUCTIONS

4-12. The following procedure is to be used to gain access to various parts of the Model 891AR:

a. Remove the six top dust cover attaching screws and remove the dust cover from the instrument. This allows access to the mounting screws of the Kelvin-Varley Divider, Reference Inverter, and Null Detector printed circuit boards.

b. Remove the top front and rear trim strip attaching screws and remove the trim strips from the instrument. This allows access to the front and rear panel components.

c. Remove the six lower dust cover attaching screws and remove the dust cover from the instrument. This allows access to the Reference Inverter printed circuit board mounting screws, all of the switches used in the instrument, and potentiometer R37.

d. Remove the lower front and rear trim strip attaching screws and remove the trim strips from the instrument. This allows further access to the front and rear panel components.

e. Remove the left and right rear panel attaching screws and slide the rear panel free from the instrument. This allows access to the power transformer T1, CR1, CR2, and any option components.

f. Loosen the front panel control knob set screws and remove all of the knobs from the front panel. Loosen the two screws securing the shutter cabling to the front panel. Remove the nuts from the front panel binding posts and remove the terminal clips from the binding posts. Remove the left and right front panel attaching screws and slide the front panel forward until free of the instrument. This allows access to the front panel meter and all switch linkages.

4-13. GENERAL MAINTENANCE

4-14. PERIODIC CLEANING

4-15. This instrument is completely enclosed, therefore no entry for dirt, dust, or lint is provided. Consequently, it is usually only necessary to clean the exterior surfaces of the instrument. To clean the exterior use a cloth moistened with anhydrous ethyl alcohol or Freon T. F. Degreaser, MS 180 Miller-Stephenson Chemical Co., Inc. If either of these cleaning agents are not readily available soap and water applied sparingly to a cloth can be used to clean the exterior of the instrument.

4-16. If it becomes necessary to clean the interior of the instrument a hot deionized or distilled water rinse followed by a thorough drying should be used. Drying temperatures in excess of 160° F should be avoided.

CAUTION!

The use of solvents, particularly keytones, is not recommended because of possible damage to the dielectric materials used in the instrument.

4-17. FUSE REPLACEMENT

4-18. Input line power to the Model 891 instruments is fused to 1/8 ampere by F1. This fuse is located on the rear panel assembly of the instrument in a bayonet fuseholder. When replacing this fuse use a 1/8A, 250 volt, slo-blo, type fuse.

4-19. BATTERY REPLACEMENT

4-20. Battery replacement on instruments containing the -01 option is necessary when 16 continuous hours of battery charging will no longer result in a satisfactory battery check. To replace the batteries, proceed as follows:

a. Obtain access to the battery pack installed on the rear panel using the disassembly procedures for your particular instrument that are described in paragraphs 4-8 through 4-12.

b. Unsolder red (or white) and black battery pack wires from their respective circuit connections and wrap the exposed ends of the wires with electricians tape.

c. Remove the four nuts and screws that attach the battery pack to the rear panel and lift the battery pack free from the instrument.

d. Locate and replace the defective batteries observing proper polarities of connections.

e. Mount the battery pack on the rear panel assembly using the screws and nuts removed in step c.

f. Remove the tape from the black battery pack wire and solder this wire to the terminal on the power transformer from which it was removed in step b.

g. Remove the tape from the red (or white) battery pack wire and solder this wire to the end of the resistor from which it was removed in step b.

h. Reassemble the instrument and check the batteries as described in Section II paragraph 2-9 and 2-10.

4-21. PRECALIBRATION AND TROUBLESHOOTING

4-22. INTRODUCTION

4-23. Before attempting to calibrate the Model 891 DC Differential Voltmeter, a parameter check of the major sections of the instrument circuitry should be performed. These precalibration checks, when the desired results are obtained, will ensure that each major section of the instrument is contributing the least possible error toward overall instrument inaccuracy. When performing these checks it may become necessary to replace component parts in order to obtain the desired results. Under these circumstances, general troubleshooting of the circuitry is necessary. As each malfunction is corrected, a complete recheck of the particular circuitry involved is also necessary.

4-24. The following tests should be performed in a draft free area at an ambient temperature of 21° to 25°C. Adjustment and test point locations are illustrated in Figure 4-2. At the beginning of each check the type of test equipment is given. Refer to Figure 4-1 for the recommended test equipment.

4-25. REFERENCE AMPLIFIER/REFERENCE INVERTER CHECKS

4-26. The Reference Amplifier/Reference Inverter Checks require an autotransformer, an ac ammeter, an oscilloscope and a dc differential voltmeter. Circuit waveforms are illustrated in Figure 4-4. To perform the checks, proceed as follows:

a. Remove the upper and lower dust covers from the instrument. Refer to paragraphs 4-8 through 4-12 for disassembly instructions.

b. Make the equipment connections illustrated in Figure 4-3 and place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1000
NULL SENS	10V
POLARITY	+
Readout dials	00.0 00

c. Apply 115 volts ac, 50-500 Hz, through the autotransformer to the Model 891. The ac ammeter should indicate less than 25 milliamperes.

d. If your instrument is equipped with the -01 option, place the POWER switch to BAT CHG, observing that the ac ammeter indication does not exceed 60 milliamperes and the ballast lamp DS1 illuminates.

e. Connect the oscilloscope signal input to terminal 3 of the Reference Amplifier Assembly and connect the oscilloscope ground to terminal 6 or 7. The waveform observed on the oscilloscope CRT should not exceed a peak-to-peak indication of 2.5 volts.

f. Disconnect the oscilloscope from the Model 891.

g. Connect the input of the dc differential voltmeter to TP14 of the A2 Reference Amplifier Assembly and connect the common lead to A2 terminal 6 or 7. The voltmeter should indicate +18.5 ±0.5 volts dc.

h. Remove ac power from the Model 891 and connect the dc differential voltmeter input to terminal 2 of the A5 Kelvin-Varley Divider Assembly.

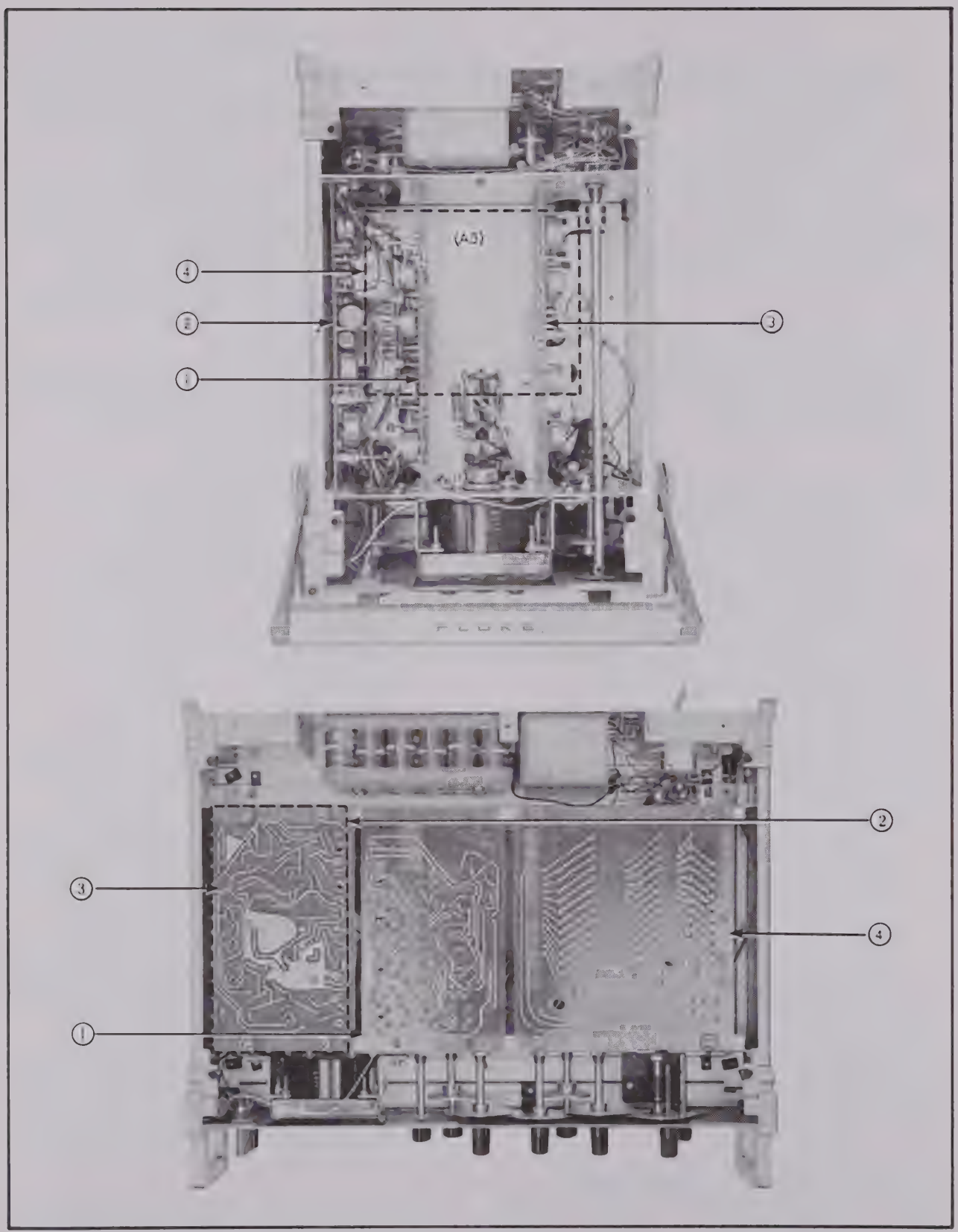


Figure 4-2. ADJUSTMENT AND TEST POINT LOCATIONS (Sheet 1 of 3)

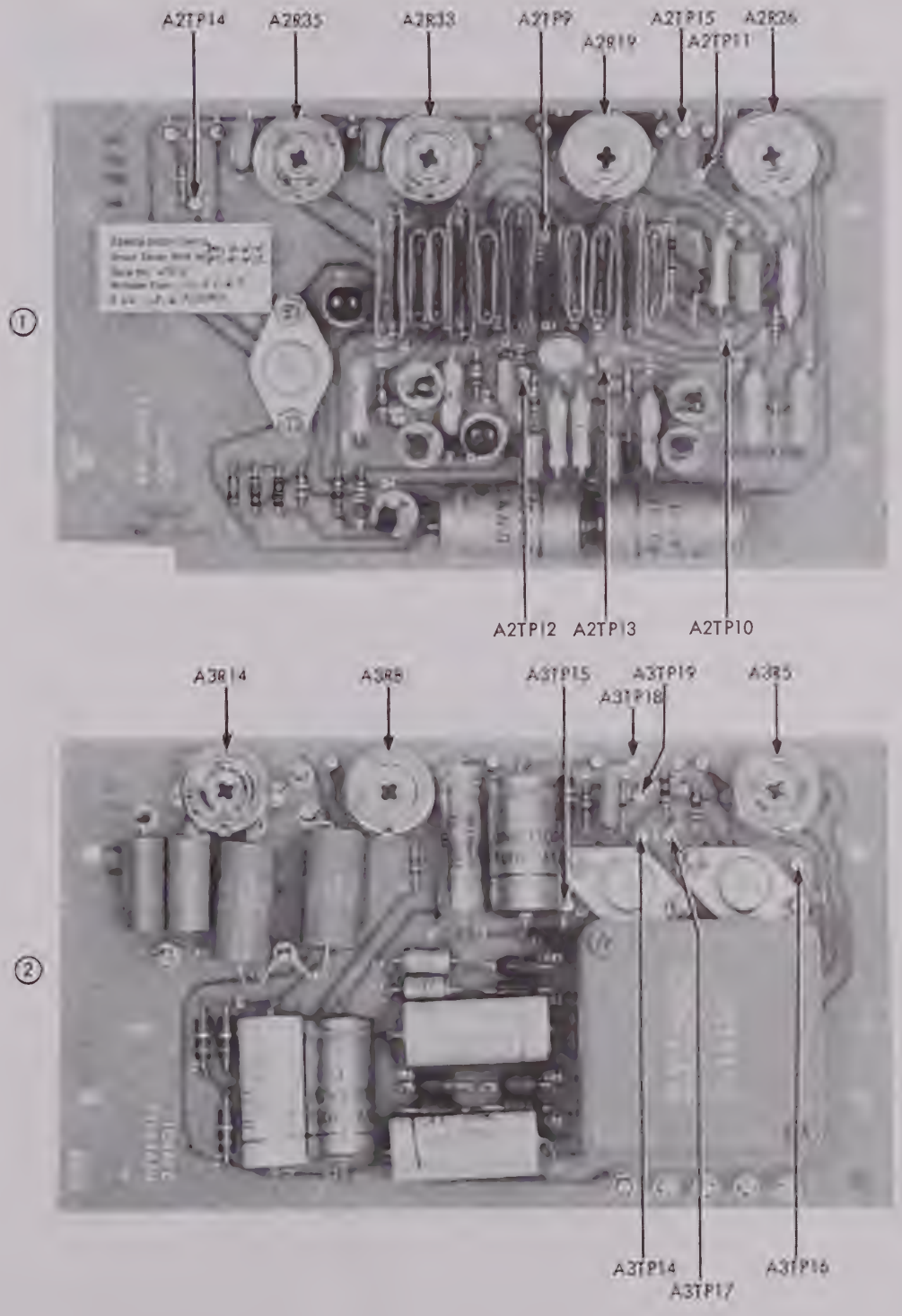


Figure 4-2. ADJUSTMENT AND TEST POINT LOCATIONS (Sheet 2 of 3)

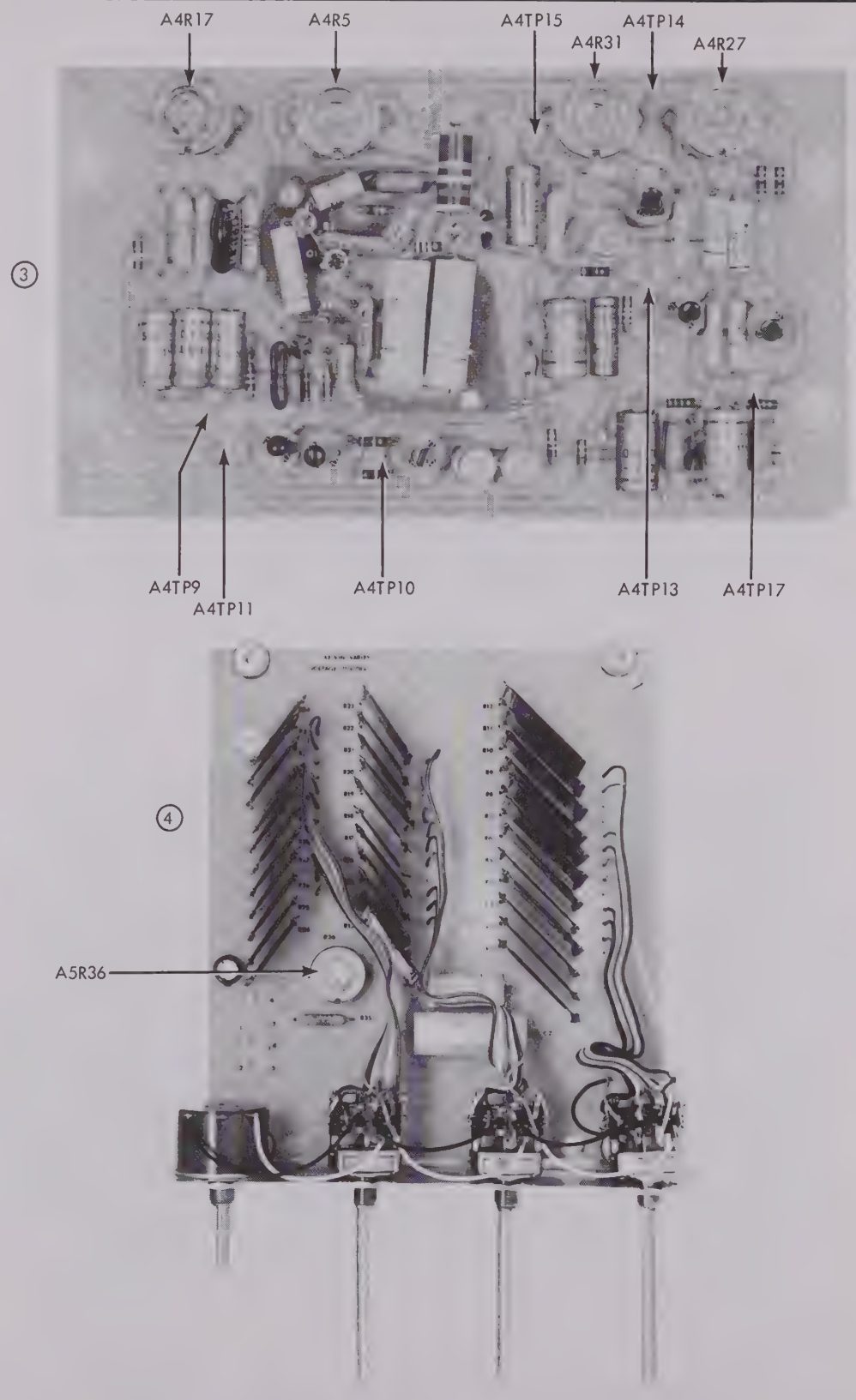


Figure 4-2. ADJUSTMENT AND TEST POINT LOCATIONS (Sheet 3 of 3)

i. Reapply ac power to the Model 891, observing that the dc differential voltmeter indicates 1100 ±0.13 volts dc.

j. Rotate A2R26 to each available limit, observing that the dc differential voltmeter indication changes by at least ±0.2 volts.

k. Adjust A2R26 for an indication of 1100 volts dc on the dc differential voltmeter.

l. Decrease the ac input voltage applied to the Model 891 to 103.5 volts ac with the autotransformer control. The voltage observed on the dc differential voltmeter should not vary more than ±0.0055 volts.

m. Increase the ac input voltage applied to the Model 891 to 126.5 volts ac with the autotransformer control. The voltage observed on the dc differential voltmeter should not vary more than ±0.0055 volts.

n. Remove ac power from the Model 891 and connect the dc differential voltmeter input to A2TP9.

o. Reapply 115 volts ac to the Model 891, observing that the dc differential voltmeter indicates 17 ±0.01 volts dc.

p. Rotate A2R19 to each available limit, observing that the dc differential voltmeter indication changes by at least ±100 millivolts.

q. Adjust A2R19 for an indication of +17 ±0.01 volts dc on the dc differential voltmeter.

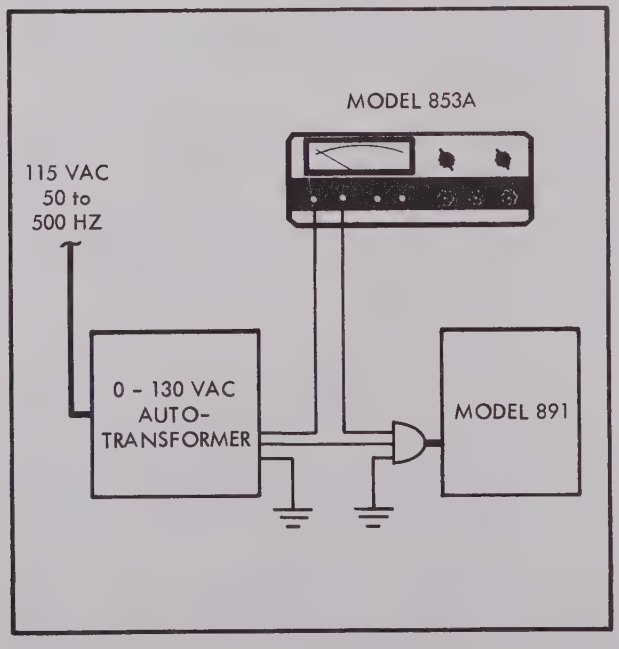


Figure 4-3. REFERENCE AMPLIFIER/REFERENCE INVERTER CHECKS - EQUIPMENT CONNECTIONS

r. Place the RANGE switch to 100 and connect the dc differential voltmeter input to terminal 2 of the A5 Kelvin-Varley Divider Assembly.

s. The dc differential voltmeter should indicate 110 ±0.009 volts dc.

t. Rotate A3R14 to each available limit, observing that the dc differential voltmeter indication changes by at least ±0.010 volts.

u. Adjust A3R14 for an indication of 110 volts dc on the dc differential voltmeter.

v. Place the RANGE switch to 10, observing that the dc differential voltmeter indicates 11 ±0.0009 volts dc.

w. Rotate A2R33 to each available limit, observing that the dc differential voltmeter indication changes by at least ± one millivolt.

x. Adjust A2R33 for an indication of 11 volts dc on the dc differential voltmeter.

y. Place the RANGE switch to 1, observing that the dc differential voltmeter indicates 1.1 volts dc ±0.9 millivolts.

z. Rotate A2R34 to each available limit, observing that the dc differential voltmeter indication changes by at least ±1 millivolt.

aa. Adjust A2R35 for an indication of 1.1 volt dc on the dc differential voltmeter.

ab. Connect the dc differential voltmeter common to terminal 1 of the A4 Null Detector Assembly and the input to TP17.

ac. Place the Model 891 NULL SENS switch to the TVM position and the RANGE switch to the 100 position.

ad. The dc differential voltmeter should indicate -6.8 volts dc ±400 millivolts. Record the exact value.

ae. Place the Model 891 RANGE switch to the 1000 position.

af. Rotate A3R8 to each available limit, observing that the dc differential voltmeter indication changes by at least ±15 millivolts.

ag. Adjust A3R8 for an indication on the dc differential voltmeter that is within 10 millivolts of the voltage recorded in step ad.

ah. Connect the oscilloscope signal input and ground to A3 terminals 10 and 9, respectively. A 3 kHz drive signal having a maximum amplitude of 13.5 volts peak-to-peak should be observed on the oscilloscope trace.

4-27. When the results of these checks agree with the information given, the Reference Amplifier/Reference Inverter Assemblies are functioning properly and the test equipment can be disconnected from the instrument.

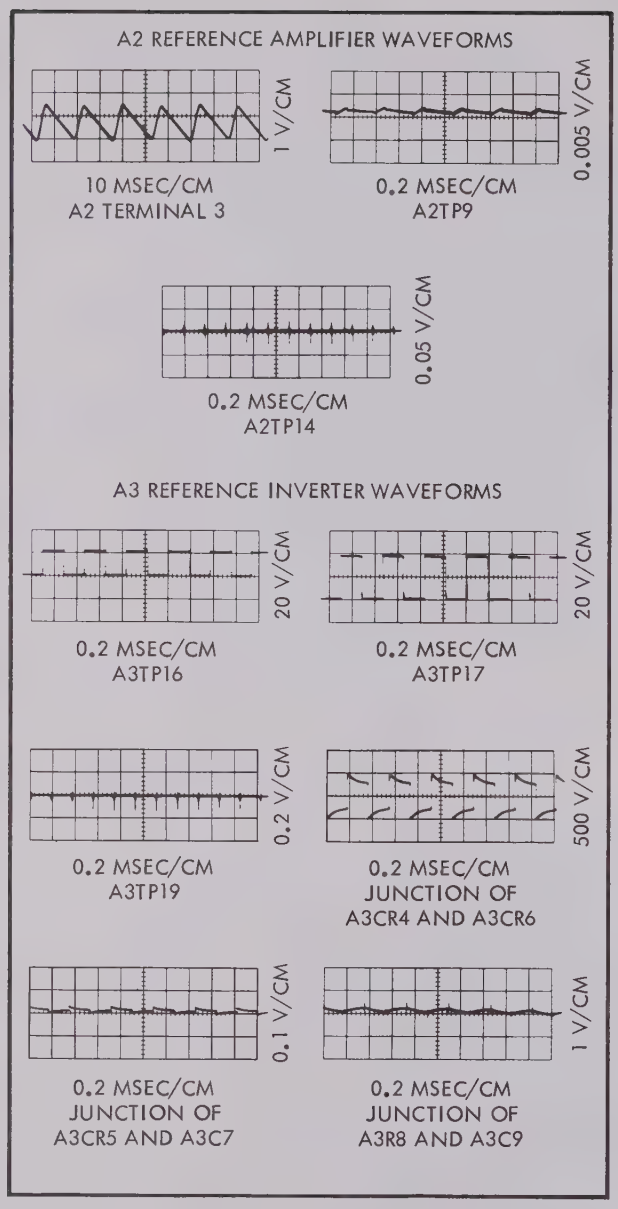


Figure 4-4. REFERENCE AMPLIFIER/REFERENCE INVERTER WAVEFORMS

4-28. NULL DETECTOR/DIVIDER CHECKS

4-29. The Null Detector/Divider Checks require a dc voltage calibrator, a dc differential voltmeter and a 10 megohm 1% resistor. Circuit waveforms are illustrated in Figure 4-6. To perform the checks, apply ac power to the instrument and proceed as follows:

a. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1
NULL SENS	.001
POLARITY	+
Readout dials	.00100

b. Connect the dc differential voltmeter input to TP16 and the common lead to terminal 7 of the Null Detector Assembly. The voltmeter should indicate +6.8 ±0.4 volts dc.

c. Connect the dc differential voltmeter input to TP17, observing that the voltmeter indicates -6.8 ±0.4 volts dc.

d. Disconnect the dc differential voltmeter from the Model 891.

e. Connect a shorting jumper between the LO and HI INPUT terminals and rotate A4R27 and A4R31 fully counter-clockwise.

f. Adjust A4R27 clockwise until a full-scale negative meter indication (-1) is obtained and then rotate the control an additional 10° clockwise.

g. Remove the shorting jumper and adjust A4R31 for an exact zero-center meter indication and then repeat steps f and g as necessary.

h. Connect the shorting jumper between the LO and HI INPUT terminals and adjust A4R5 to each available limit. The meter pointer should deflect above and below the minus 1 indication.

i. Adjust A4R5 for a full-scale (-1) indication on the meter.

j. Remove the shorting jumper between the INPUT terminals and replace with a 10 megohm 1% resistor.

k. Place the Readout dials to .00200 and adjust A4R17 to each available limit, observing that the meter pointer deflects above and below the minus 1 indication.

l. Adjust A4R17 for a full-scale (-1) indication on the meter.

m. Remove the 10 megohm resistor from between the INPUT terminals of the instrument and place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1
NULL SENS	.001
POLARITY	+
Readout dials	.00000

n. Connect the output of the dc voltage calibrator between the LO and HI INPUT terminals.

o. Apply the dc input voltages versus the ranges indicated in Figure 4-5, observing that the meter indicates full-scale (+1) ± 1-1/2 small divisions.

4-30. When the results of the checks agree with the information given, the Null Detector and Divider circuitry are functioning properly and the test equipment can be disconnected from the instrument.

INPUT DC VOLTAGE	RANGE	NULL SENS
.001	1	1 mv
.01	1	.01v
.1	1	.1 v
1.0	1	TVM
10.0	10	TVM
100.0	100	TVM
1000.0	1000	TVM

Figure 4-5. INPUT DC VOLTAGE VERSUS RANGE-CHECKS

4-31. KELVIN-VARLEY DIVIDER CHECKS

4-32. The Kelvin-Varley Divider Checks require the use of a dc voltage calibrator. The Precalibration and Troubleshooting Checks of paragraphs 4-21 through 4-30 must also have been performed to ascertain that the associated instrument circuitry is functioning correctly. To perform the checks, apply ac power to the instrument and proceed as follows:

a. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	10
NULL SENS	.001
POLARITY	+
Readout dials	10.000

b. Apply +10 volts dc from a dc voltage calibrator between the Model 891 LO and HI INPUT terminals.

c. Adjust A2R33 for a zero-center meter indication on the Model 891.

d. Apply the dc input voltages versus the Readout dial settings of Figure 4-7, observing that the Model 891 meter indicates zero-center within the major division deviation.

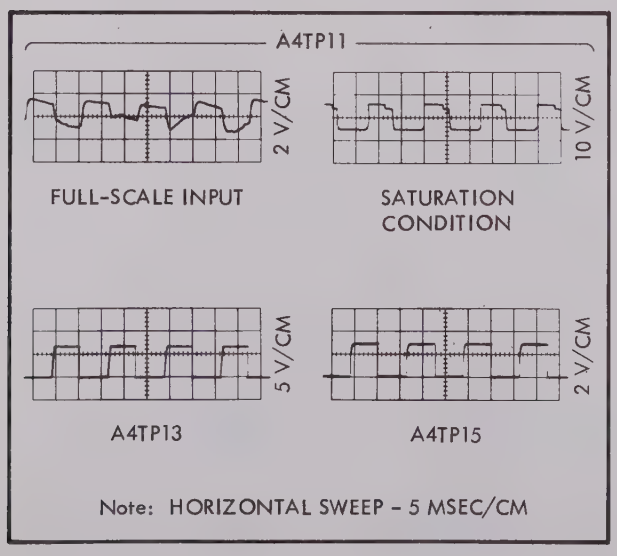


Figure 4-6. NULL DETECTOR WAVEFORMS

INPUT DC VOLTAGE	READOUT DIAL SETTINGS	MAJOR DIVISION DEVIATION
11.000	10.99 X	±5.5
10.000	10.00 O	null reference
10.00	9.99 X	±5.0
9.999	9.99 90	±4.99
8.888	8.88 80	±4.44
7.777	7.77 70	±3.88
6.666	6.66 60	±3.33
5.555	5.55 50	±2.77
4.444	4.44 40	±2.22
3.333	3.33 30	±1.66
2.222	2.22 20	±1.11
1.111	1.11 10	± .55
1.000	1.00 0	± .5

Figure 4-7. INPUT VOLTAGES VERSUS READOUT SETTINGS - CHECKS

4-33. When the results of these checks agree with the information given, the Kelvin-Varley Divider circuitry is functioning properly and the test equipment can be disconnected from the instrument.

4-34. RECORDER OUTPUT OPTION CHECKS

4-35. The Recorder Output Option Checks require the use of a dc differential voltmeter. Circuit waveforms are illustrated in Figure 4-8. To perform the checks, apply ac power to the instrument and proceed as follows:

a. Connect the inputs of a dc differential voltmeter to the rear panel HI and LO RECORDER OUTPUT terminals and rotate the associated level control fully clockwise.

b. Connect a shorting jumper between the LO and HI INPUT terminals of the Model 891 and place the controls as follows:

POWER	ON/LINE OPR
RANGE	1
NULL SENS	.001
POLARITY	+
Readout dials	.00100

c. A dc voltage of -0.2 to -0.28 volts dc should be indicated on the dc differential voltmeter connected to the RECORDER OUTPUT terminals.

d. Rotate the RECORDER OUTPUT level control counter-clockwise, observing that the RECORDER OUTPUT voltage decreases to zero volts.

e. Adjust the RECORDER OUTPUT level control for an indication of 0.2 volts on the dc differential voltmeter.

f. Place the Model 891 Readout dials to .00010, observing that the RECORDER OUTPUT voltage indicated on the dc differential voltmeter is -0.02 volts dc.

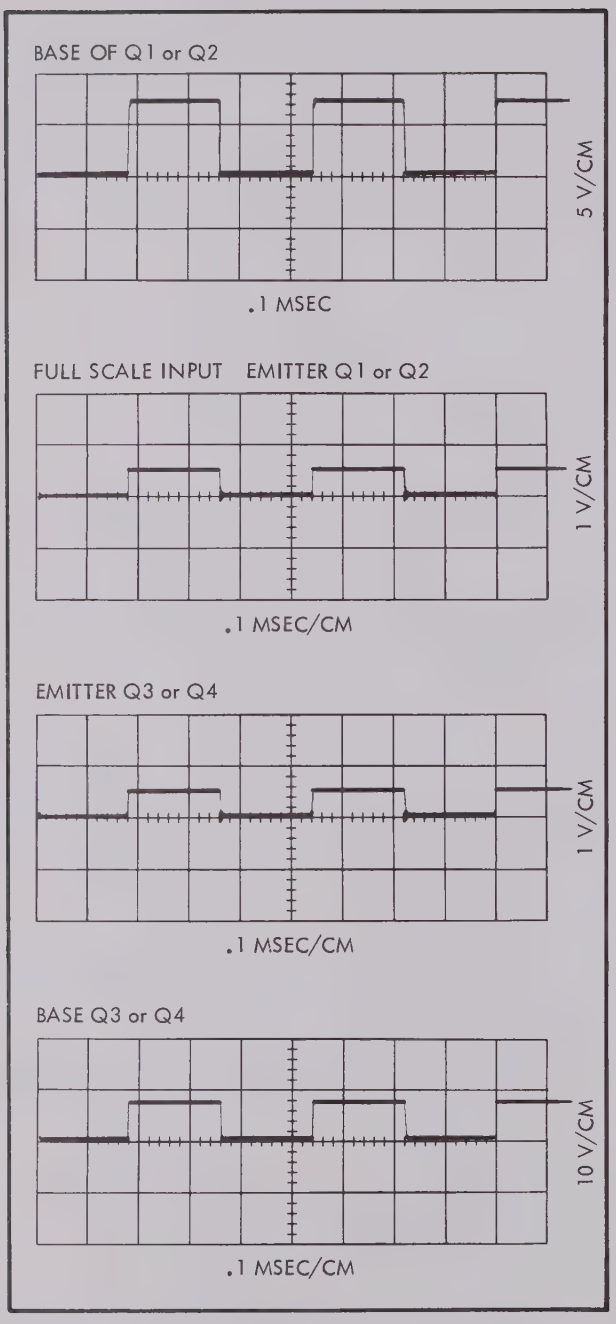


Figure 4-8. RECORDER OUTPUT WAVEFORMS

4-36. When the results of these checks agree with the information given, the Recorder Output Option circuitry is functioning properly and the test equipment can be disconnected from the instrument.

4-37. CALIBRATION PROCEDURES

4-38. INTRODUCTION

4-39. The Model 891 should be checked for calibration annually. Before attempting to calibrate your instrument, it is recommended that the major portions of the instrument circuitry be checked using the methods described in the preceding Precalibration and Troubleshooting (paragraphs 4-21 through 4-36).

4-40. It will be necessary to apply dc voltages from a known accurate source to the input of the instrument during calibration. A dc voltage calibrator such as the John Fluke Model 332B can be used to obtain the necessary accurate dc voltages.

4-41. Calibration of the instrument should be performed on line power with the top and bottom dust covers removed from the instrument. An ambient room temperature from 21° to 25°C in a draft free area should be maintained during calibration. Adjustments and test points locations are illustrated in Figures 4-2. Figure 4-9 contains a list of the calibration adjustments and their effects.

4-42. METER MECHANICAL ZERO ADJUST

4-43. With the power removed from the Model 891, proceed as follows:

a. Position the instrument horizontally (normal position) on the bench.

b. Adjust the meter mechanical zero screw, accessible from the front panel, until the meter pointer indicates zero-center. Back-off the screw adjustment just enough to disengage the cam once the center-zero indication is obtained.

4-44. ZENER REFERENCE SUPPLY CALIBRATION

4-45. To calibrate the Zener Reference Supply, apply ac power to the instrument and proceed as follows:

a. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1
NULL SENS	TVM
POLARITY	+
Readout dials	.00000

b. Connect a dc differential voltmeter to A2TP9 and adjust A2R19 for an indication of +17 ±0.01 volts dc.

c. Disconnect the dc differential voltmeter.

4-46. NULL DETECTOR CALIBRATION

4-47. To calibrate the Null Detector circuitry, proceed as follows:

a. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1
NULL SENS	1 mv
POLARITY	+
Readout dials	.00100

CIRCUITRY	ADJUSTMENTS AND THEIR EFFECTS	
ZENER REFERENCE SUPPLY	A2R19	Used to adjust for 17±0.01 volts dc at A2TP9 and has a minor effect on instrument calibration. Adjustment of this control establishes a specific voltage for the zener diodes which minimizes the zeners temperature coefficient and increases their voltage stability.
NULL DETECTOR	A4R27	Adjusts the gate signal drive level of Q1 for optimum chopping efficiency. Inadequate drive to the gate of Q1 will result in a lower than specified null detector input resistance and a lower gain. Excessive drive to the gate of Q1 (clockwise setting) will reduce the null detector stability.
	A4R31	Adjusts the level of the signal applied to the drain of Q1. This signal is used to cancel out the null detector open-circuit offset effects produced by the gate to drain capacitance of Q1. Misadjustment of this control will produce null detector open circuit offsets particularly noticable on the .001 volt sensitivity.
	A4R5	Adjusts the null detector gain to compensate for variations in the carrier amplifier gain, full-scale meter sensitivity, and feedback resistor tolerances.
	A4R17	Adjusts the carrier amplifier gain which determines the input resistance of the null detector and to a minor degree affects null detector sensitivity.
	A3R8	Adjusted to provide uniform null detector voltages of ±6.8 volts dc on all voltage ranges. This adjustment does not affect instrument calibration.
	A3R5	Adjusted to reduce the 3 kHz common mode signal from A3T1 that is present at the common terminal of the null detector. This adjustment does not affect instrument calibration.
KELVIN-VARLEY DIVIDER	A5R36	Provides a means of trimming the full-scale vernier dial range to compensate for potentiometer resistance tolerance.
1000 VOLT RANGE	A2R26	Adjusts the value of the reference voltage for the +18.5 volt dc regulator to a value necessary to calibrate the 1000 volt range. Adjustment of this resistor will also effect calibration of the 100 volt range but does not effect the 1 and 10 volt range calibration.
100 VOLT RANGE	A3R14	Adjusts the 110 volts dc applied to the Kelvin-Varley Divider on the 100 volt range. Adjustment of this resistor will not effect the calibration of any other voltage range.
10 VOLT RANGE	A2R33	Adjusts the 11 volts dc applied to the Kelvin-Varley Divider on the 10 volt range. Adjustment of this resistor will not effect the calibration of any other range.
1 VOLT RANGE	A2R35	Adjusts the 1.1 volts dc applied to the Kelvin-Varley Divider on the 1 volt range. Adjustment of this resistor will not effect the calibration of any other range.

Figure 4-9. SUMMARY OF CALIBRATION ADJUSTMENTS

b. Connect a shorting jumper between the LO and HI INPUT terminals and rotate A4R27 and A4R31 fully counter-clockwise.

c. Adjust A4R27 clockwise until negative (-) deflection of the meter pointer reaches a maximum and then continue an additional 10° clockwise.

d. Remove the INPUT terminals shorting jumper and adjust A4R31 for a meter pointer indication of zero-center ±1/4 small divisions.

e. Connect the shorting jumper between the LO and HI INPUT terminals and adjust A4R5 for an exact full-scale (-1) meter pointer indication.

f. Replace the shorting jumper between the INPUT terminals with a 10 megohm 1% resistor and place the Readout dials to .00200.

g. Adjust A4R17 for an exact full-scale (-1) meter pointer indication.

h. Repeat steps e through g until the specified results are obtained.

i. Replace the resistor between the INPUT terminals with a shorting jumper.

j. On each RANGE and NULL SENS switch setting, place the Readout dials to the voltage indicated on the NULL SENS switch, observing that the meter pointer indicates full-scale (-1) ±1 small division. On the one volt range, perform the checks in both positions of the POLARITY switch.

k. Remove the INPUT terminal shorting jumper and place the NULL SENS switch to TVM.

l. Apply the dc voltages to the Model 891 INPUT terminals on the ranges indicated in Figure 4-10, observing that the meter pointer indicates a corresponding positive or negative full-scale (±1) ±1 small division.

INPUT DC VOLTAGE (±0.3%)	RANGE
±1	1
±10	10
±100	100
±1000	1000

Figure 4-10. TVM RANGE CHECKS

m. Remove the dc input voltage and connect a dc differential voltmeter between A4TP17 and the LO INPUT terminal.

n. Place the RANGE switch to 100 and the Readout dials to 00.000 and record the dc differential voltmeter indication.

o. Place the RANGE switch to 1000 and adjust A3R8 for a dc voltage within ±10 millivolts of the voltage recorded in step n.

p. Disconnect the dc differential voltmeter and connect an oscilloscope ground lead to the LO INPUT terminal and the input lead to terminal 1 of the A4 Null Detector Assembly.

q. Place the RANGE switch to 1000 and the Readout dials to 100.00. Adjust A3R5 for minimum amplitude of the 3 kHz squarewave observed on the oscilloscope CRT.

4-48. KELVIN-VARLEY DIVIDER CALIBRATION

4-49. To calibrate the Kelvin-Varley Divider, apply ac power to the instrument and proceed as follows:

a. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	10
NULL SENS	.001
POLARITY	+
Readout dials	0.01 00

b. Apply a dc input voltage between the LO and HI INPUT terminals and adjust its level to obtain a zero-center meter pointer indication.

c. Place the Readout dials to 0.00 X and adjust A5R36 for a zero-center meter pointer indication.

4-50. VOLTAGE RANGE CALIBRATION

4-51. To calibrate the Voltage Ranges of the Model 891, apply ac power to the instrument and proceed as follows:

a. Disconnect the shorting link from the LO INPUT terminal and place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	1000
NULL SENS	.1
POLARITY	+
Readout dials	1000. 00

b. Apply a dc calibration voltage of 1,000 ±0.002% volts dc between the LO and HI INPUT terminals and center the adjustment A2R26, observing that the Model 891 meter indicates center-zero ±0.6.

c. If the result of step b is obtained, proceed with step f. If the desired results are not obtained, perform steps d through f.

d. Remove ac power to the instrument and connect the jumpers illustrated in Figure 4-11 between their respective circuit board connections.

e. Reapply ac power to the instrument and, using the information provided in Figure 4-12, clip the corresponding jumper or jumpers.

f. Adjust A2R26 for an exact zero-center meter indication.

g. Reduce the calibration voltage to 100 ±0.002% volts dc and place the RANGE switch to 100.

h. With the NULL SENS switch to 0.01, adjust A3R14 for an exact zero-center meter pointer indication.

i. Reduce the calibration voltage to 10 ±0.002% volts dc and place the RANGE switch to 10.

j. With the NULL SENS switch to .001, adjust A2R33 for an exact center-zero meter pointer indication.

k. Reduce the calibration voltage to 1 ±0.002% volts dc and place the RANGE switch to 1.

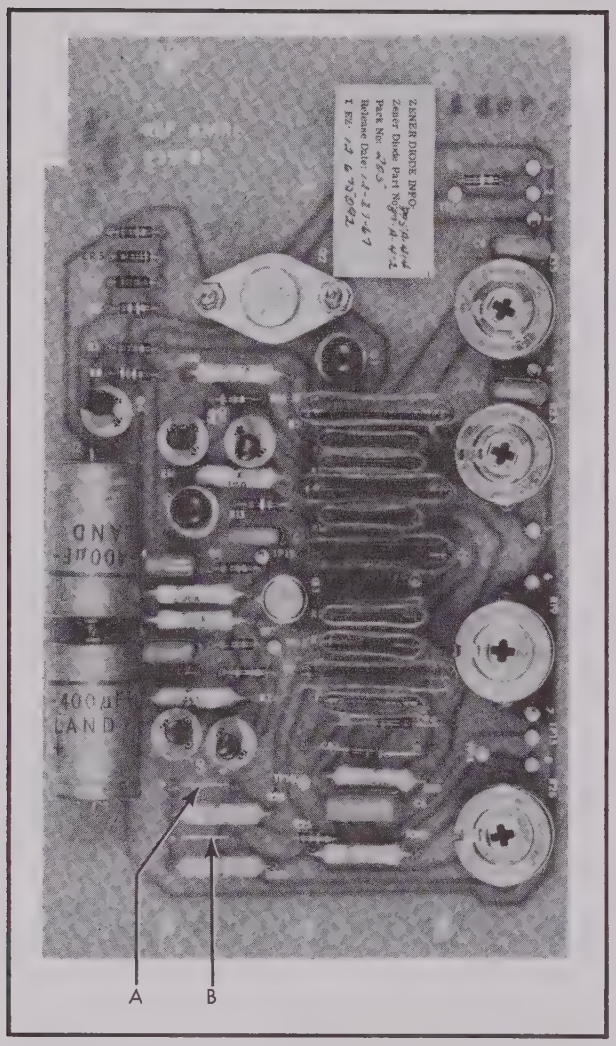


Figure 4-11. JUMPER WIRE LOCATION

l. With the NULL SENS switch to .001, adjust A2R35 for an exact zero-center meter pointer indication.

m. Reduce the calibration voltage to 80 millivolts ±0.1% and place the RANGE switch to 100.

n. Place the Readout dials to 00.080, observing that a zero-center meter indication is obtained within ±1/4 of a small division on the vernier Readout dial.

o. If the results of step n are not obtained, adjust the vernier Readout dial for an exact zero-center meter indication and loosen the set screw that secures the vernier dial indicator to the potentiometer shaft. Refer to Figure 4-13 for location of the set screw.

METER INDICATION	JUMPER WIRE
0 to ±0.6	NONE
-0.6 to -1.8	B
-1.8 to -3.0	A
-3.0 and above	BOTH

Figure 4-12. JUMPER WIRE SELECTION

p. Position the vernier dial indicator for a front panel indication of 80 and securely tighten the set screw.

q. Remove the calibration voltage from the Model 891 and place a shorting jumper between the LO and HI INPUT terminals.

r. Place the Model 891 controls as follows:

POWER	ON/LINE OPR
RANGE	10
NULL SENS	.001
POLARITY	+
Readout dials	00.000

s. Rotate the vernier Readout dial until a full-scale (-1) meter pointer indication is obtained, observing that the vernier Readout dial indication is between 9 and 11.

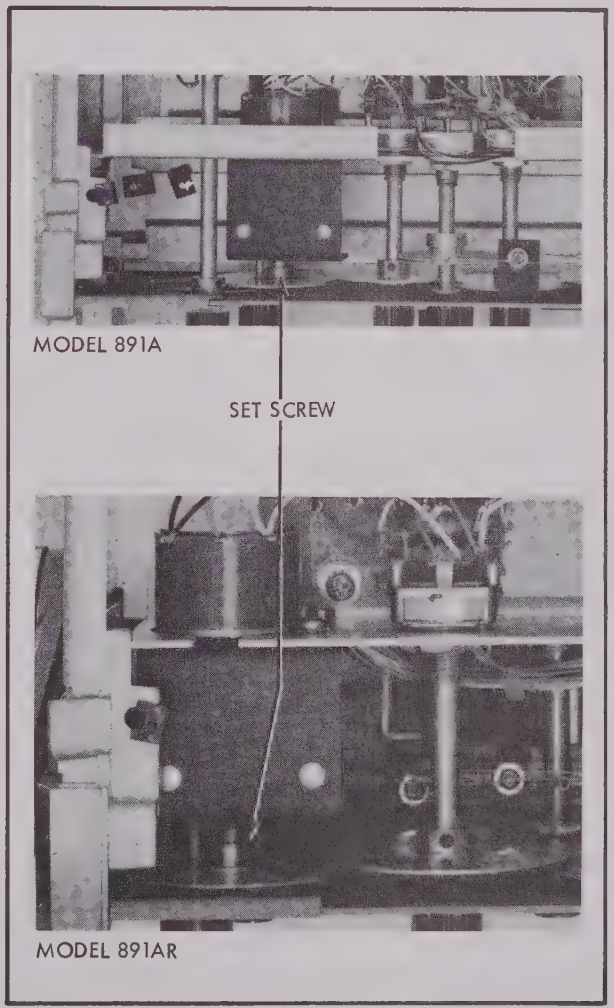


Figure 4-13. VERNIER DIAL SET SCREW LOCATION

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section of the manual contains a listing of replaceable components for this instrument. The first listing contains a complete breakdown of all the major assemblies followed by subsequent listings that itemize the components on each major assembly. An illustration accompanies each major assembly listing to aid in locating the listed components.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A followed by a number (e.g., A1 etc.). Electrical components appearing on the schematic diagram are identified by their schematic diagram reference designation. Components not appearing on the schematic diagram are consecutively numbered throughout the parts list. These components are identified with whole numbers on the arrow call-out illustrations and by index numbers on the grid illustrations. Flagnotes are used throughout the parts list and refer to special ordering explanations that are located in close proximity to the flagnotes.

5-4. COLUMN DESCRIPTION

a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The INDEX NO. column lists coordinates which locate the designated part on the associated grid illustrations.

c. The DESCRIPTION column describes the salient characteristics of the component. Indention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, see the following page.

d. The ten-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

e. The Federal Supply Code for the item manufacturer is listed in the MFR column. An abbreviated list of Federal Supply Codes is included in the Appendix.

f. The part number which uniquely identifies the item to the original manufacturer is listed in the MFR PART NO column. If a component must be ordered by description, the type number is listed.

g. The TOT QTY column lists the total quantity of the items used in the instrument and reflects the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF. In the case of optional subassemblies, plug ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the TOT QTY column lists the total quantity of the item in that particular assembly.

h. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated side, it is recommended that at least one of every part in the instrument be stocked. In the case of optional subassemblies, plug ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

i. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List at the end of the parts list. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

5-5. HOW TO OBTAIN PARTS

5-6. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representative by using the Fluke part number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-7. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co. if you include the following information:

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation.

e. Instrument model and serial number.

Example: 2 each, 4805-177105, Transistors, 2N3565, Q107-108 for 845AR, s/n 168.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part showing its location to other parts of the instrument is usually most helpful.

5-8. LIST OF ABBREVIATIONS

ac	alternating current
Al	Aluminum
amp	ampere
assy	assembly
cap	capacitor
car flm	carbon film
C	centigrade
cer	ceramic
comp	composition
conn	connector
db	decibel
dc	direct current
dpdt	double-pole, double-throw
dpst	double-pole, single-throw
elect	electrolytic
F	fahrenheit
Ge	germanium
gmv	guaranteed minimum value
h	henry
Hz	hertz
hf	high frequency
IC	integrated circuit
if	intermediate frequency
k	kilohm
kHz	kilohertz
kv	kilovolt
lf	low frequency
MHz	megahertz
M	megohm
met flm	metal film
ua	microampere
uf	microfarad
uh	microhenry
usec	microsecond
uv	microvolt
ma	milliampere
mh	millihenry
m	milliohms
msec	millisecond
mv	millivolt
mw	milliwatt
na	nanoampere
nsec	nanosecond
nv	nanovolt
Ω	ohm
ppm	parts per million
piv	peak inverse voltage
p-p	peak to peak
pf	picofarad
plstc	plastic
p	pole
pos	position
P/C	printed circuit
rf	radio frequency
rfi	radio frequency interference
res	resistor
rms	root mean square
rtry	rotary
sec	second
sect	section
S/N	serial number
Si	silicon
scr	silicon controlled rectifier
spdt	single-pole, double-throw
spst	single-pole, single-throw
sw	switch
Ta	tantalum
tstr	transistor
tvm	transistor voltmeter
uhf	ultra high frequency
vtvm	vacuum tube voltmeter
var	variable
vhf	very high frequency
vlf	very low frequency
v	volt
va	voltampere
vac	volts, alternating current
vdc	volts, direct current
w	watt
ww	wire wound

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		DC DIFFERENTIAL VOLTMETER Figure 5-1	891A					
A1		Front Panel Assembly (See Figure 5-2)						
A2		Reference Amplifier P/C Assembly (See Figure 5-3)	1702-232793 (891A-4001)	89536	1702-232793	1		
A3		Reference Inverter P/C Assembly (See Figure 5-4)	1702-232801 (891A-4002)	89536	1702-232801	1		
A4		Null Detector P/C Assembly (See Figure 5-5)	1702-232819 (891A-4003)	89536	1702-232819	1		
A5		Kelvin-Varley P/C Assembly (See Figure 5-6)	1702-232827 (891A-4004)	89536	1702-232827	1		
A7		Rear Panel Assembly (See Figure 5-7)						
M1		Meter, 100-0-100 ua	2901-236513	89536	2901-236513	1		
P1, P2		Line cord (not illustrated)	6005-226100	91934	2270			
R1		Res, car flm, 90M ±1%, 2w	4703-192138	75042	MEHT-X	1		
R2		Res, car flm, 9M ±0.5%, 1w	4703-107557	75042	Type C13	1		
R3		Res, car flm, 1M ±1%, 1/2w	4703-107219	75042	Type C12	1		
R4		Res, car flm, 90k ±0.5%, 1/2w	4703-107292	75042	Type C12	1		
R5		Res, car flm, 9k ±0.5%, 1/2w	4703-107250	75042	Type C12	1		
R6		Res, car flm, 900Ω ±0.5%, 1/2w	4703-107771	75042	Type C12	1		
R7		Res, car flm, 100Ω ±0.5%, 1/2w	4703-107730	75042	Type C12	1		
R9		Res, comp, 1k ±10%, 1w	4704-109371	01121	GB1021	1		
S1		Switch, rotary, RANGE	5105-242867	89536	5105-242867	1		
S2		Switch, rotary, POWER	5105-242917	89536	5105-242917	1		
S3		Switch, rotary, NULL	5105-242875	89536	5105-242875	1		
S4		Switch, rotary, POLARITY	5105-242883	89536	5105-242883	1		
1		Coupler, power switch	2402-104505	89536	2402-104505	1		
2		Cover, bottom (not illustrated)	3156-230169	89536	3156-230169	1		
3		Cover, top (not illustrated)	3156-230151	89536	3156-230151	1		
4		Dial, 0-9	2403-232215	89536	2403-232215	2		
5		Dial, 0-10	2403-232207	89536	2403-232207	1		
6		Dial, 0-100	2403-242859	89536	2403-242859	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
7		Foot, plastic (not illustrated)	3155-230037	89536	3155-230037	4		
8		Handle	2906-231456	89536	2906-231456	1		
9		Indicator, ON-OFF flag	3156-232223	89536	3156-232223	1		
10		Shaft, power switch	2406-232157	89536	2406-232157	1		
11		Trim strip, front (not illustrated)	3154-230771	89536	3154-230771	2		
12		Trim strip, rear (not illustrated)	3154-230789	89536	3154-230789	2		
13		Trim strip, side insert (not illustrated)	3155-230920	89536	3155-230920	2		

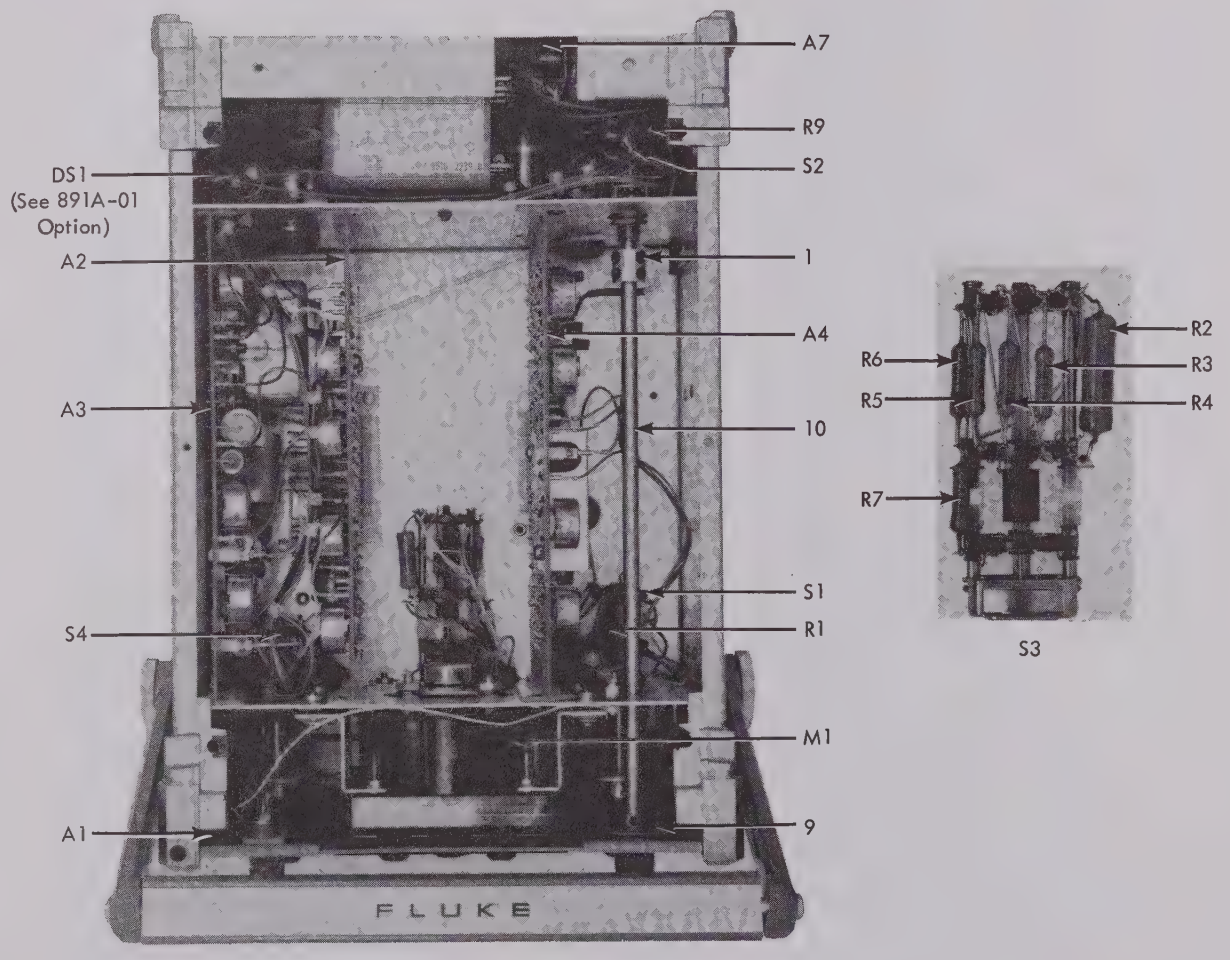


Figure 5-1. 891A DC DIFFERENTIAL VOLTMETER (Sheet 1 of 2)

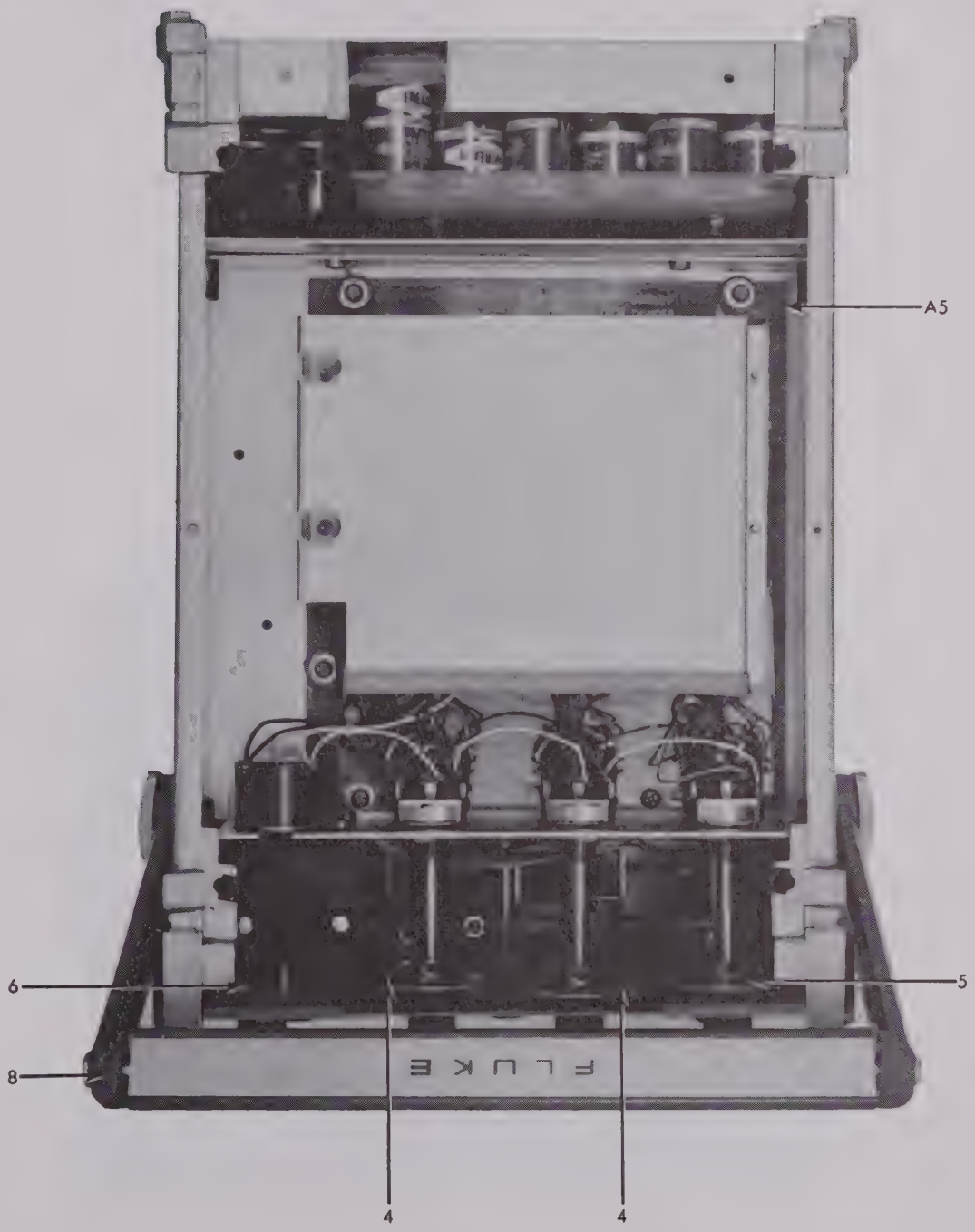


Figure 5-1. 891A DC DIFFERENTIAL VOLTMETER (Sheet 2 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1		**FRONT PANEL ASSEMBLY (891A) Figure 5-2**						
C1		Cap, plstc, 0.047uf ±20%, 1.2kv	1507-182683	99217	MR473L12	2		
J1		Binding post, red, HI	2811-226308	58474	DF21RC	2		
J2		Binding post, red, LO	2811-226308	58474	DF21RC	REF		
J3		Binding post, black GROUND	2811-226282	58474	DF21BC	1		
R8		Res, comp, 100M ±10%, 1/2w	4704-190520	01121	EB1071	1		
14		Knob, Digit	2405-158949	89536	2405-158949	4		
15		Knob, NULL SENS, POLARITY, RANGE	2405-158956	89536	2405-158956	3		
16		Knob, POWER	2405-235689	89536	2405-235689	1		
17		Link, shorting	2811-101220	24655	938L	1		
18		Panel, front	1406-231910	89536	1406-231910	1		

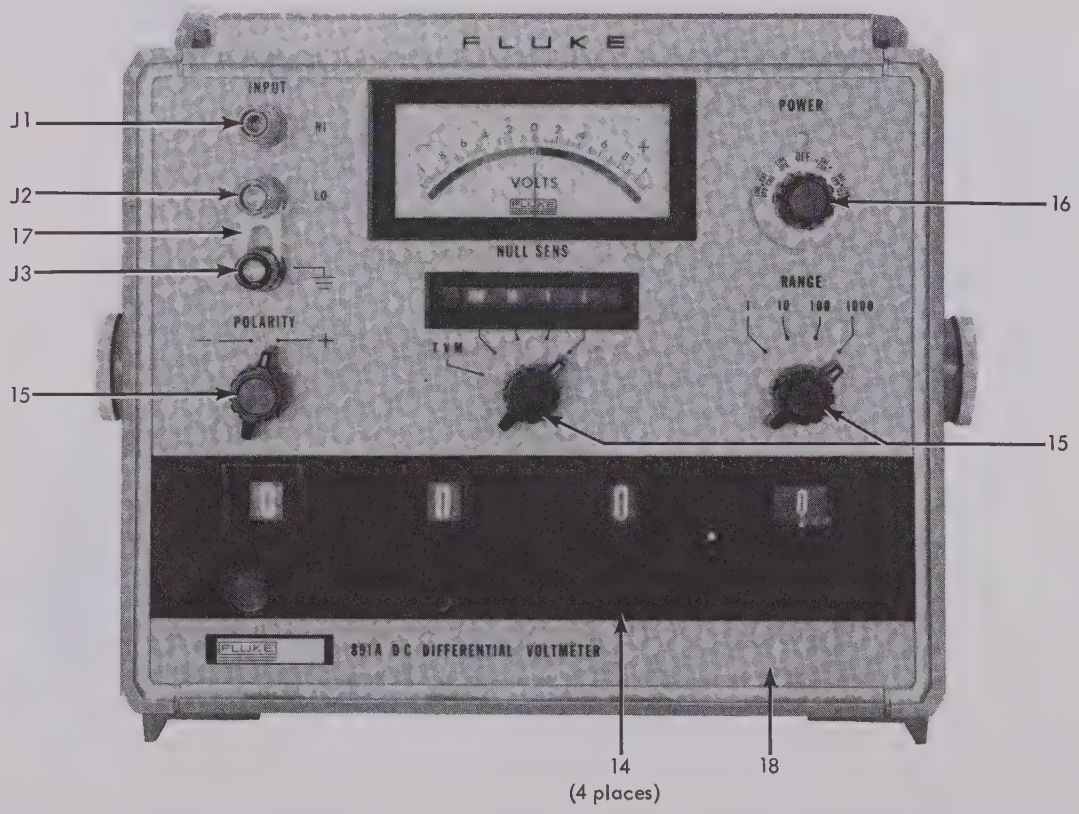


Figure 5-2. FRONT PANEL ASSEMBLY (891A)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A2		**REFERENCE AMPLIFIER P/C ASSEMBLY - Figure 5-3** NOTE: The Reference Amplifier P/C Assembly (A2), the Reference Inverter P/C Assembly (A3) and their intermatched resistor set can be ordered under one part number, 1702-244194 (891A-4015).	1702-232793 (891A-4001)	89536	1702-232793	REF		
C1	F4-P1	Cap, elect, 400uf +50/-10% 40v	1502-185868	73445	C437ARG400	2	1	
C2	D4-P1	Cap, elect, 400uf +50/-10%, 40v	1502-185868	73445	C437ARG400	REF		
C3	F4-R1	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	9		
C4	F2-Q1	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C5	F2-P5	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C6	C3-S2	Cap, plstc, 0.22uf ±20%, 250v	1507-194803	73445	C280AE/ P220K	1		
C7	H2-T5	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C8	I5-U1	Cap, plst, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C9	I3-P3	Cap, Ta, 3.3uf ±10%, 20v	1508-182808	05397	K3R3C20K	1		D
CR1	I3-P3	Diode, silicon, 150 ma, 6 piv	4802-113308	07910	CD13161	2	1	
CR2	E1-P5	Diode, silicon, 150 ma, 6 piv	4802-113308	07910	CD13161	REF		
CR3	D1-S2	Diode, zener, matched	1					
CR4	D3-S3	Diode, zener, matched	1					
CR5	I5-P3	Diode, zener, 15v	4803-246033	07910	IN965A	1	1	B
Q1	H4-R5	Tstr, silicon, PNP	4805-203364	07263	2N3638	1		G
	H4-R5	Tstr, silicon, PNP	4805-229898	04713	MPS6522	2	1	H
Q2	I2-R1	Tstr, silicon, NPN	4805-183004	95303	40250	3	1	
Q3	E5-R2	Tstr, silicon, NPN	4805-220087	03508	12E-1516	1	1	
Q4	H2-P1	Tstr, silicon, NPN	4805-168708	03508	2N3391	9	1	
Q5	D2-Q1	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
Q6	D1-Q3	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
Q7	F5-Q2	Tstr, silicon, PNP	4805-203364	07263	2N3638	1	1	
Q8	G4-Q1	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
Q9	G4-Q5	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
R1	J1-P3	Res, comp, 15k ±5%, 1/4w	4704-148114	01121	CB1535	1		

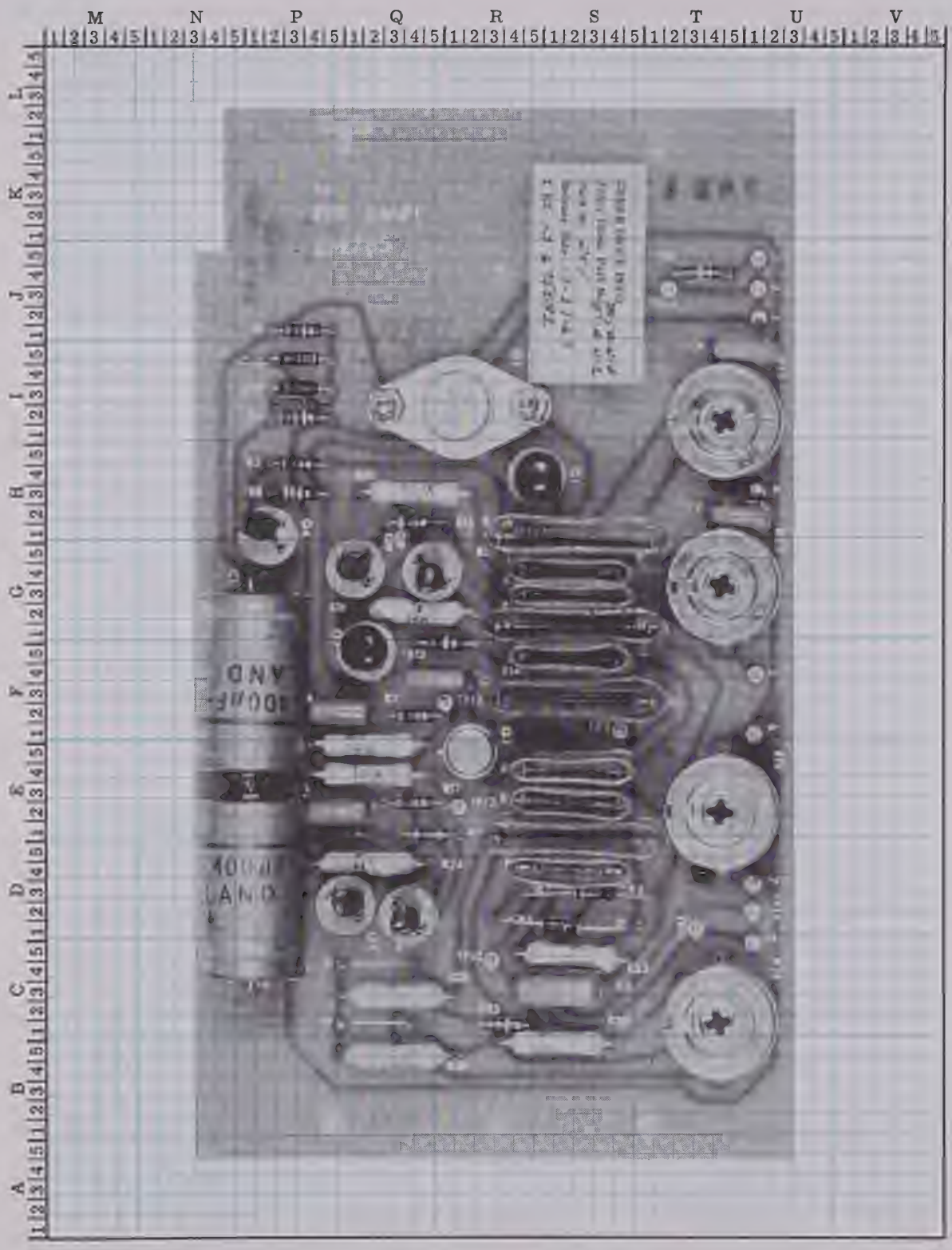


Figure 5-3. REFERENCE AMPLIFIER P/C ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R2	I5-P3	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	1		A
R3	H1-R5	Res, comp, 2.7k ±5%, 1/4w	4704-170720	01121	CB2725	1		
R4	J4-T3	Res, comp, 62k ±5%, 1/4w	4704-220053	01121	CB6235	1		
R5	H5-P3	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	6		
R6	E5-Q3	Res, met flm, 196k ±1%, 1/2w	4705-161513	75042	Type CEC-TO	2		
R7	F2-Q4	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		
R8	H3-P3	Res, comp, 47k ±5%, 1/4w	4704-148163	01121	CB4735	1		
R9	I2-P3	Res, comp, 680k ±5%, 1/4w	4704-188433	01121	CB6845	2		
R10	E1-Q5	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		
R11	E4-Q2	Res, met flm, 196k ±1%, 1/2w	4705-161513	75042	Type CEC-TO	REF		
R12	E2-Q4	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		
R13	G1-R1	Res, comp, 100k ±5%, 1/4w	4704-148189	01121	CB1045	2		
R14	F5-S1	Res, ww, matched	1					
R15	H2-Q4	Res, comp, 3k ±5%, 1/4w	4704-193508	01121	CB3025	1		
R16	G2-Q4	Res, met flm, 9k ±1%, 1/2w	4705-159434	75042	Type CEC-TO	1		
R17	F3-R5	Res, ww, 4k ±0.03%, 1w	4707-131672	89536	4707-131672	1		
R18	G1-R5	Res, ww, 10k ±0.05%, 1w	4707-131664	89536	4707-131664	1		
R19	E3-T4	Res, var, ww, 3k ±10%, 1-1/4w	4702-112458	71450	Type 110	1		
R20	H3-Q4	Res, met flm, 60.4k ±1%, 1/2w	4705-161067	75042	Type CEC-TO	1		
R21	D4-S2	Res, ww, 12.525Ω, matched	2					
R22	E4-S2	Res, ww, 12.525Ω, matched	2					
R23	C5-S2	Res, met flm, 499k ±1%, 1/2w	4705-151332	75042	Type CEC-TO	2		
R24	D4-Q2	Res, met flm, 34k ±1%, 1/2w	4705-151241	75042	Type CEC-TO	2		
R25	C1-R3	Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	1		
R26	C2-T5	Res, var, ww, 1k ±20%, 1-1/4w	4702-111575	71450	Type 110	2		
R27	E2-S3	Res, ww, matched	1					
R28	C3-Q3	Res, met flm, 95.3Ω ±1%, 1/2w	4705-155127	75042	Type CEC-TO	1		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R29	B5-Q3	Res, met flm, 47.5Ω ±1%, 1/2w	4705-151290	75042	Type CEC-TO	1		
R30	B5-R5	Res, met flm, 52.3Ω ±1%, 1/2w	4705-155069	75042	Type CEC-TO	1		
R31	E1-R4	Res, ww, 49.488k ±0.05%, 1w	4707-163444	89536	4707-163444	1		
R32	G3-S2	Res, ww, matched	1					
R33	G3-T3	Res, var, ww, 25Ω ±10%, 1-1/4w	4702-161703	71450	Type 110	2		
R34	H1-S5	Res, ww, 49.488k, matched	3					
R35	I3-T4	Res, var, ww, 25Ω ±10%, 1-1/4w	4702-161703	71450	Type 110	REF		
R36	G4-S2	Res, ww, 5.481k, matched	3					

1 CR3, CR4, R14, R27 & R32 are a factory matched set and must be replaced as an entire set. For replacement, order Zener-Resistor Set, part number 4807-219303.

2 A2R21, A2R22/A3R12, A3R13, A3R15 & A3R16 are factory matched for tolerance and temperature coefficient. Individual resistors can be replaced by giving model, serial number, full reference designation and all information stamped on the resistor.

3 R34 & R36 are factory matched and must be replaced as a set. For replacement, order Reference Divider Resistor Set, part number 4710-219295.

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A3		**REFERENCE INVERTER P/C ASSEMBLY - Figure 5-4** NOTE: The Reference Amplifier P/C Assembly (A2), the Reference Inverter P/C Assembly (A3) and their intermatched resistor set can be ordered under one part number, 1702-244194 (891A-4015).	1702-232801 (891A-4002)	89536	1702-232801	REF		
C1	F3-T2	Cap, elect, 400uf +50/-10%, 25v	1502-168153	73445	C437ARF400	2	1	
C2	H5-P4	Cap, elect, 400uf +50/-10%, 25v	1502-168153	73445	C437ARF400	REF		
C3	E2-T4	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C4	G4-R4	Cap, elect, 5uf +50/-10%, 64v	1502-218966	73445	C426ARH5	2	1	
C5	C4-R2	Cap, elect, 5uf +50/-10%, 64v	1502-218966	73445	C426ARH5	REF		
C6	G2-T1	Cap, elect, 10uf +75/-10%, 150v	1502-106351	56289	30D106G150 DF4	1	1	
C7	G1-Q4	Cap, plstc, 0.47uf ±20%, 600v	1507-105494	72928	363-114M	2		
C8	G2-P2	Cap, plstc, 0.47uf ±20%, 600v	1507-105494	72928	363-114M	REF		
C9	I4-P5	Cap, plstc, 0.047uf ±20%, 1.2kv	1507-182683	99217	MR473L12	REF		
CR1	E1-T4	Diode, germanium, 80 ma, 100 piv	4802-149187	49956	IN270	3	1	
CR2	F3-R4	Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	6	1	
CR3	F3-R2	Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	REF		
CR4	F3-Q1	Diode, silicon, 1 amp, 600 piv	4802-112383	05277	IN4822	4	1	
CR5	G3-Q1	Diode, silicon, 1 amp, 600 piv	4802-112383	05277	IN4822	REF		
CR6	F3-P5	Diode, silicon, 1 amp, 600 piv	4802-112383	05277	IN4822	REF		
CR7	G3-P5	Diode, silicon, 1 amp, 600 piv	4802-112383	05277	IN4822	REF		
Q1	E1-S4	Tstr, silicon, NPN	4805-183004	95303	40250	REF		
Q2	C3-S4	Tstr, silicon, NPN	4805-183004	95303	40250	REF		
R1	E5-T5	Res, comp, 2Ω ±5%, 1/2w	4704-218735	01121	EB20G5	1		
R2	E4-T4	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	4		
R3	D4-T5	Res, comp, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	2		
R4	D2-T4	Res, comp, 33Ω ±5%, 1/4w	4704-175034	01121	CB3305	REF		
R5	C1-T4	Res, var, ww, 1k ±20%, 1-1/4w	4702-111575	71450	Type 110	REF		
R6	C3-S2	Res, comp. 100Ω ±5%, 1/4w	4704-147926	01121	CB1015	1		
R7	G5-S5	Res, comp, 5.1k ±5%, 1/4w	4704-193342	01121	CB5125	1		

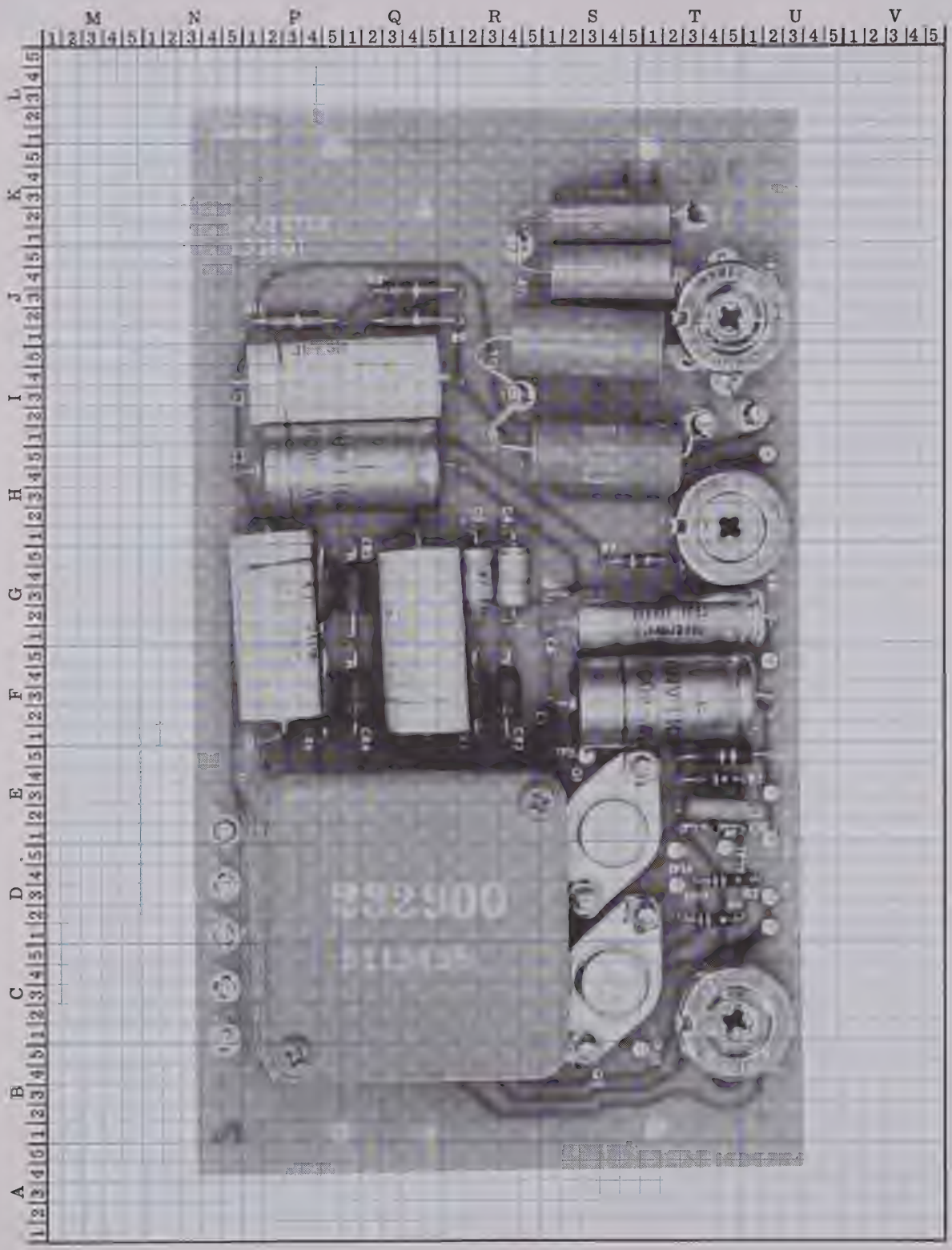


Figure 5-4. REFERENCE INVERTER P/C ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R8	H1-T4	Res, var, ww, 6k ±5%, 1-1/4w	4702-113209	71450	Type 110	1		
R9	J2-Q4	Res, comp, 5.6M ±10%, 1/2w	4704-178558	01121	EB5651	3		
R10	J3-Q4	Res, comp, 5.6M ±10%, 1/2w	4704-178558	01121	EB5651	REF		
R11	J2-P3	Res, comp, 5.6M ±10%, 1/2w	4704-178558	01121	EB5651	REF		
R12	H5-S4	Res, ww, 1M, matched	2					
R13	J1-S3	Res, ww, 1M, matched	2					
R14	J2-T4	Res, var, ww, 100Ω ±20%, 1-1/4w	4702-112797	71450	Type 110	1		
R15	J4-S4	Res, ww, 98.582k, matched	2					
R16	K2-S4	Res, ww, 98.582k, matched	2					
T1	C5-Q5	Transformer, toroid	5602-232900	89536	5602-232900	1		

2 A2R21, A2R22/A3R12, A3R13, A3R15 & A3R16 are factory matched for tolerance and temperature coefficient. Individual resistors can be replaced by giving model, serial number, full reference designation and all information stamped on the resistor.

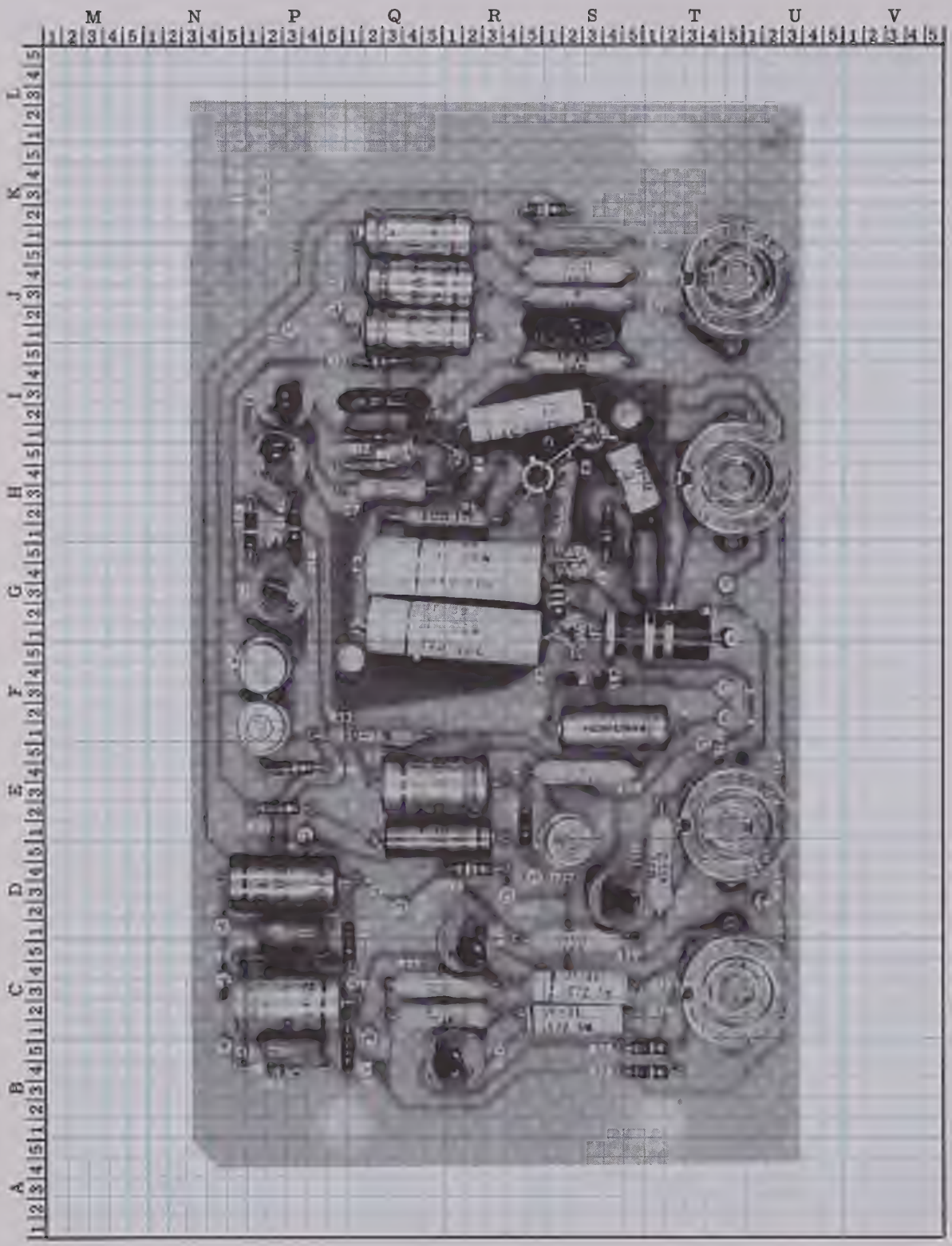


Figure 5-5. NULL DETECTOR P/C ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A4		**NULL DETECTOR P/C ASSEMBLY** Figure 5-5	1702-232819 (891A-4003)	89536	1702-232819	REF		
C1	G1-Q5	Cap, plstc, 0.1uf ±20%, 120v	1507-167460	99217	Type SEC	2		
C2	G4-Q5	Cap, plstc, 0.1uf ±20%, 120v	1507-167460	99217	Type SEC	REF		
C3	I2-R5	Cap, plstc, 0.047uf ±10%, 80v	1507-195099	56289	192P4739R8	1		
C4	H4-S5	Cap, cer, 3pf ±10%, 500v	1501-226316	00656	Type C1-1	1		
C5	G5-T1	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C6	J1-Q4	Cap, elect, 50uf +50/-10%, 25v	1502-168823	73445	C426ARF50	3	1	
C7	H3-Q3	Cap, plstc, 0.0047uf ±20%, 200v	1507-106054	56289	192P47202	1		
C8	J1-S2	Cap, plstc, 0.01uf ±10%, 200v	1507-168450	14655	DMF2S1	1		
C9	K1-Q5	Cap, elect, 50uf +50/-10%, 25v	1502-168823	73445	C426ARF50	REF		
C10	I3-Q3	Cap, mica, 2,200pf ±5%, 500v	1504-148346	14655	CD19F222J	1		
C11	J4-Q5	Cap, elect, 50uf +50/-10%, 25v	1502-168823	73445	C426ARF50	REF		
C12	E1-Q5	Cap, elect, 10uf +50/-10%, 25v	1502-170266	73445	C426ARF10	1	1	
C13	E3-Q5	Cap, elect, 400uf +50/-10%, 4v	1502-187773	73445	C426ARB400	1	1	
C14	C2-S2	Cap, plstc, 0.022uf ±5%, 200v	1507-233973	56289	192P22352	2		
C15	C3-S2	Cap, plstc, 0.022uf ±5%, 200v	1507-233973	56289	192P22352	REF		
C16	D1-P3	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C17	B5-P3	Cap, plstc, 0.1uf ±20%, 250v	1507-161992	73445	C280AE/ P100K	REF		
C18	D3-P3	Cap, elect, 125uf +50/-10%, 16v	1502-186296	73445	C426ARE125	2	1	
C19	C2-P3	Cap, elect, 125uf +50/-10%, 16v	1502-186296	73445	C426ARE125	REF		
C20	F1-S4	Cap, elect, 80uf +50/-10%, 16v	1502-192914	73445	C426ARE80	1	1	
CR1	F4-S3	Diode, silicon, treated	4802-180885	89536	4802-180885	2	1	
CR2	F4-S2	Diode, silicon, treated	4802-180885	89536	4802-180885	REF		
CR3	C5-P3	Diode, germanium, 80 ma, 100 piv	4802-149187	49956	IN270	REF		
CR4	B4-P2	Diode, germanium,80 ma, 100 piv	4802-149187	49956	IN270	REF		
Q1	H4-R5	Tstr, MOS, P-channel	4805-229674	07263	2N4065	1	1	E
	H4-R5	Tstr, MOS, P-channel	4805-226043	07263	FT704	1	1	F
Q2	I1-Q4	Tstr, silicon, NPN	4805-194456	89536	4805-194456	1	1	E
	I1-Q4	Tstr, silicon, NPN	4805-242065	04713	2N5089	2	1	F
Q3	I3-P3	Tstr, silicon, NPN	4805-168716	07263	S19254	1		E
	I3-P3	Tstr, silicon, NPN	4805-242065	04713	2N5089	REF		F
Q4	H5-P2	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
Q5	G3-P2	Tstr, silicon, PNP	4805-229898	04713	MPS6522	REF		
Q6	F4-P2	Tstr, germanium, NPN	4805-117127	01295	2N1304	1		
Q7	F1-P2	Tstr, germanium, PNP	4805-190298	95303	2N1305	1	1	
Q8	D5-S2	Tstr, germanium, NPN	4805-182691	01295	GA2875	1	1	
Q9	C5-R2	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
Q10	B4-R1	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
Q11	D2-S5	Tstr, silicon, NPN	4805-168708	03508	2N3391	REF		
R1	G1-S5	Res, comp, 470k ±10%, 2w	4704-110247	01121	HB4741	1		
R2	G3-S1	Res, comp, 470k ±5%, 1/4w	4704-188441	01121	CB4745	1		
R3	H3-S2	Res, car flm, 330k ±1%, 1/2w	4703-107359	75042	Type C12	1		
R4	G2-T1	Res, comp, 56Ω ±5%, 1/4w	4704-147900	01121	CB5605	1		
R5	H3-T4	Res, var, ww, 500Ω ±10%, 1-1/4w	4702-112433	71450	Type 110	1		
R6	H2-R1	Res, car flm, 10Ω ±1%, 1/2w	4703-107789	75042	Type C12	1		
R7	H1-S4	Res, comp, 10M ±5%, 1/4w	4704-194944	01121	CB1065	1		
R8	H5-R1	Res, comp, 3.3M ±10%, 1/2w	4704-108282	01121	EB3351	1		
R9	H5-Q2	Res, comp, 1.5M ±5%, 1/4w	4704-182857	01121	CB1555	1		
R10	J4-S2	Res, met flm, 169Ω ±1%, 1/2w	4705-151183	75042	Type CEC-TO	2		
R11	K2-S1	Res, comp, 680k ±5%, 1/4w	4704-188433	01121	CB6845	REF		
R12	I1-Q2	Res, comp, 1M ±5%, 1/4w	4704-182204	01121	CB1055	1		
R13	I5-Q2	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	2		
R14	H1-P3	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R15	I5-S2	Res, met flm, 42.2k ±1%, 1/2w	4705-182501	75042	Type CEC-TO	1		C
R15	I5-S2	Res, met flm, 80.6k ±1%, 1/2w	4705-150680	75042	Type CEC-TO	1		D
R16	J3-S2	Res, met flm, 169Ω ±1%, 1/2w	4705-151183	75042	Type CEC-TO	REF		
R17	J3-T4	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	4		
R18	K1-S2	Res, met flm, 17.8k ±1%, 1/2w	4705-162545	75042	Type CEC-TO	1		C
R18	K1-S2	Res, met flm, 10k ±1%, 1/2w	4705-151274	75042	Type CEC-TO	1		D
R19	E4-P3	Res, comp, 27k ±5%, 1/4w	4704-148148	01121	CB2735	REF		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R20	E2-P2	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		
R21	E1-R5	Res, comp, 1k ±5%, 1/4w	4704-148023	01121	CB1025	REF		
R22	E4-S3	Res, met flm, 2.55k ±1%, 1/2w	4705-176362	75042	Type CEC-TO	2		
R23	D4-R2	Res, comp, 39k ±5%, 1/4w	4704-188466	01121	CB3935	1		
R24	C2-Q5	Res, met flm, 383k ±1%, 1/2w	4705-176388	75042	Type CEC-TO	1		
R25	C3-Q5	Res, met flm, 499k ±1%, 1/2w	4705-151332	75042	Type CEC-TO	REF		
R26	B4-T1	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R27	C2-T4	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	REF		
R28	B5-T1	Res, comp, 10k ±5%, 1/4w	4704-148106	01121	CB1035	REF		
R29	D1-S2	Res, met flm, 825Ω ±1%, 1/2w	4705-155119	75042	Type CEC-TO	1		C
R29	D1-S2	Res, met flm, 309Ω ±1%, 1/2w	4705-172130	75042	Type CEC-TO	1		D
R30	D4-T1	Res, met flm, 2.55k ±1%, 1/2w	4705-176362	75042	Type CEC-TO	REF		
R31	E1-T4	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	REF		
R32	F1-Q1	Res, car flm, 10k ±1%, 1/2w	4703-107128	75042	Type C12	1		
R33	D1-Q1	Res, comp, 110Ω ±5%, 1/4w	4704-193474	01121	CB1115	2		
R34	B5-Q1	Res, comp, 110Ω ±5%, 1/4w	4704-193474	01121	CB1115	REF		
R35	H1-P1	Res, comp, 100k ±5%, 1/4w	4704-148189	01121	CB1045	REF		
		Shield (not illustrated)	3156-232082	89536	3156-232082	1		

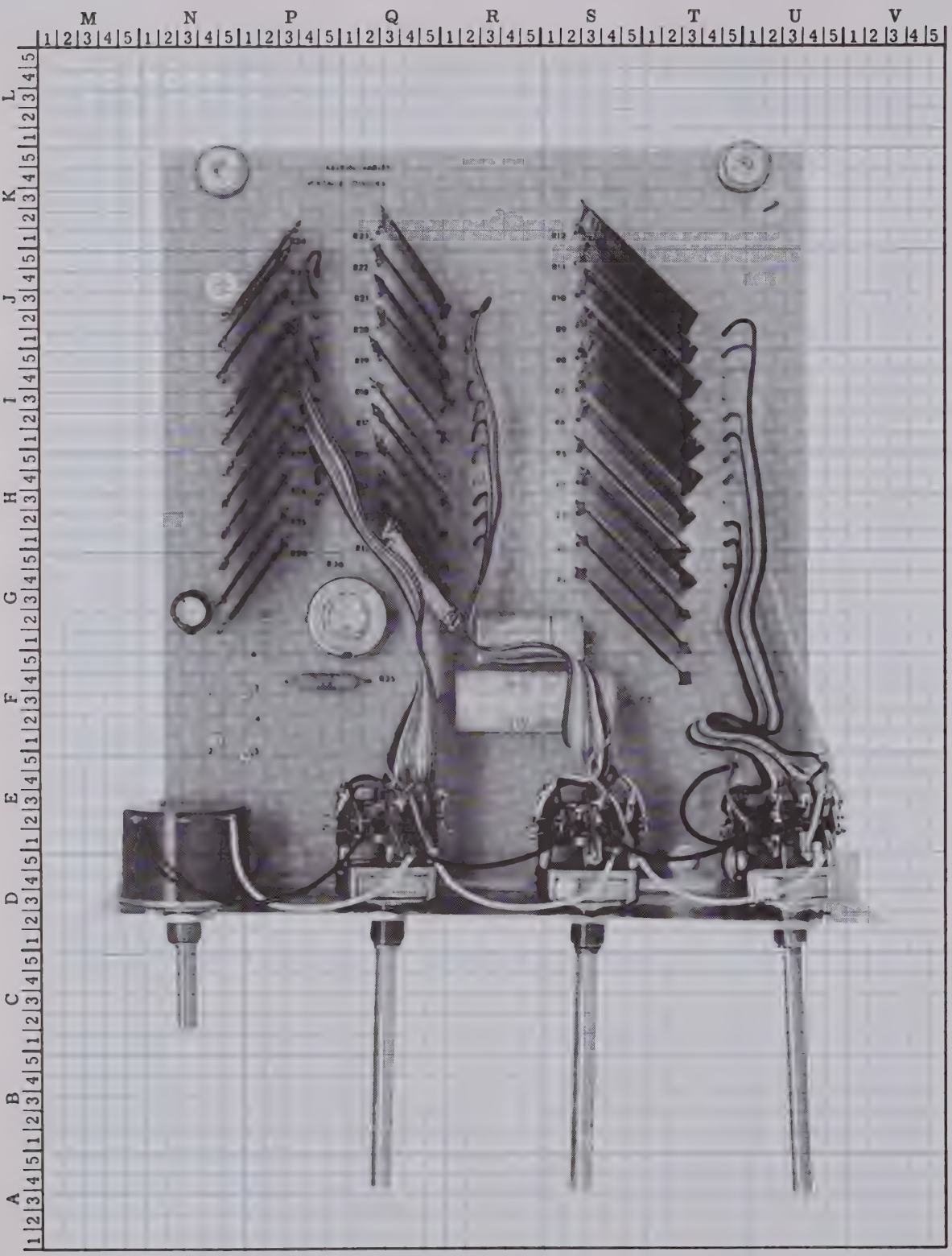


Figure 5-6. KELVIN-VARLEY P/C ASSEMBLY

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A5		**KELVIN-VARLEY P/C ASSEMBLY Figure 5-6**	1702-232827 (891A-4004)	89536	1702-232827	REF		
C1	G1-R4	Cap, plstc, 1uf ±20%, 200v	1507-106450	84411	Type X663F	1		
C2	F3-R5	Cap, plstc, 1uf ±20%, 120v	1507-193748	84411	JF-11	1		
R1	G3-S4	Res, ww, 100k	5					
R2	G4-S4	Res, ww, 100k						
R3	H1-S4	Res, ww, 100k						
R4	H3-S4	Res, ww, 100k						
R5	H4-S4	Res, ww, 100k						
R6	I1-S4	Res, ww, 100k						
R7	I3-S4	Res, ww, 100k						
R8	I4-S5	Res, ww, 100k						
R9	I5-S5	Res, ww, 100k						
R10	J2-S5	Res, ww, 100k						
R11	J4-S4	Res, ww, 100k						
R12	K1-S4	Res, ww, 100k						
R13	G2-R1	Res, ww, 20k						
R14	H3-Q3	Res, ww, 20k						
R15	H4-Q3	Res, ww, 20k						
R16	H5-Q3	Res, ww, 20k						
R17	H5-Q4	Res, ww, 20k						
R18	I3-Q3	Res, ww, 20k						
R19	I5-Q3	Res, ww, 20k						
R20	J2-Q3	Res, ww, 20k						
R21	J3-Q3	Res, ww, 20k						
R22	J5-Q3	Res, ww, 20k						
R23	J5-Q4	Res, ww, 20k						
R24	G5-P2	Res, ww, 4k						
R25	H1-P2	Res, ww, 4k						
R26	H3-P2	Res, ww, 4k						
R27	H5-P2	Res, ww, 4k	5					

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R28	I1-P2	Res, ww, 4k	5					
R29	I1-P1	Res, ww, 4k						
R30	I4-P2	Res, ww, 4k						
R31	I5-P2	Res, ww, 4k						
R32	J1-P1	Res, ww, 4k						
R33	J1-N5	Res, ww, 4k						
R34	J4-P1	Res, ww, 4k	5					
R35	F4-P5	Res, met flm, 34k ±1%, 1/2w	4705-151241	75042	Type CEC-TO	REF		
R36	G2-P5	Res, var, ww, 10k ±20%, 1-1/4w	4702-112862	71450	Type 110	REF		
R37	E1-N3	Res, var, ww, 10k ±5%	4702-232868	89536	4702-232868	1		
S6	D4-U2	Switch, rotary, KV Dial "A"	5105-242891	89536	5105-242891	1		
S7	D4-S2	Switch, rotary, KV Dial "B"	5105-242909	89536	5105-242909	2		
S8	D4-Q4	Switch, rotary, KV Dial "C"	5105-242909	89536	5105-242909	REF		
		Cover (not illustrated)	3156-235697	89536	3156-235697	1		

5 R1 through R34 are factory matched for tolerance and temperature coefficient. Individual resistors can be replaced by giving model, serial number, full reference designation and all information stamped on the resistor.

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A7		**REAR PANEL ASSEMBLY (891A)** Figure 5-7						
CR1		Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	REF		
CR2		Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	REF		
CR3		Diode, silicon, 1 amp, 100 piv (not illustrated)	4802-116111	05277	IN4817	REF		
CR4		Diode, silicon, 1 amp, 100 piv (not illustrated)	4802-116111	05277	IN4817	REF		
F1		Fuse, slow blow, 1/8 amp, 250v (for 115v operation) (not illustrated)	5105-166488	71400	Type MDL	1	2	
F1		Fuse, slow blow, 1/16 amp, 250v (for 230v operation) (not illustrated)	5105-163030	71400	Type MDL	1	2	
J4		Connector, male, 3 contact	2109-222612	82389	AC3G	1		
S5		Switch, slide	5106-226274	82389	46256-LF	1		
T1		Transformer, power	5602-223990	89536	5602-223990	1		
XF1		Holder, fuse	2102-160846	75915	342004	1		
19		Panel, rear	1406-231928	89536	1406-231928	1		

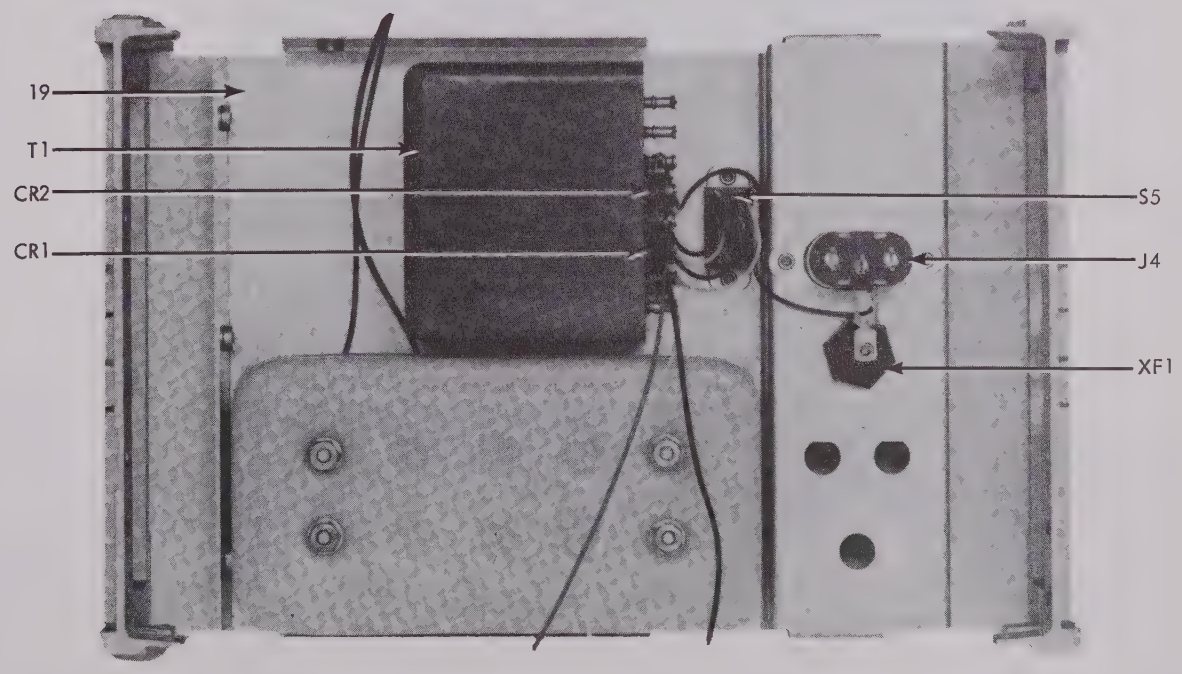
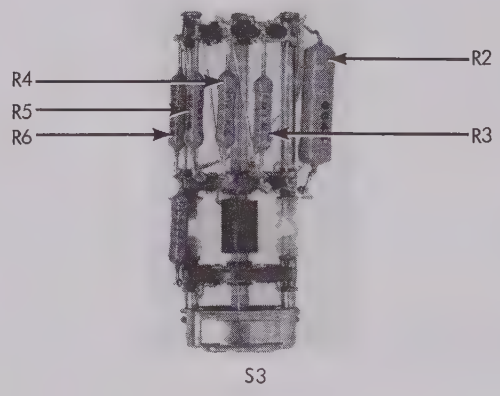


Figure 5-7. REAR PANEL ASSEMBLY (891A)



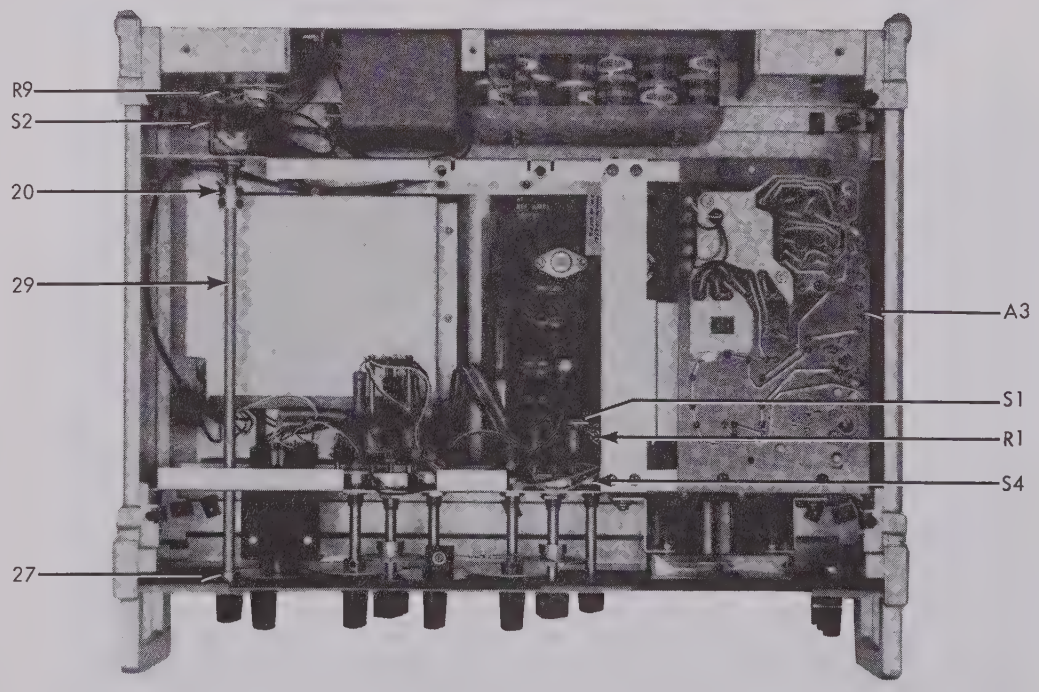


Figure 5-8. 891AR DC DIFFERENTIAL VOLTMETER (Sheet 1 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		DC DIFFERENTIAL VOLTMETER Figure 5-8	891AR					
A1		Front Panel Assembly (See Figure 5-9)						
A2		Reference Amplifier P/C Assembly (See Figure 5-3)	1702-232793 (891A-4001)	89536	1702-232793	1		
A3		Reference Inverter P/C Assembly (See Figure 5-4)	1702-232801 (891A-4002)	89536	1702-232801	1		
A4		Null Detector P/C Assembly (See Figure 5-5)	1702-232819 (891A-4003)	89536	1702-232819	1		
A5		Kelvin-Varley P/C Assembly (See Figure 5-6)	1702-232827 (891A-4004)	89536	1702-232827	1		
A7		Rear Panel Assembly (See Figure 5-10)						
M1		Meter, 100-0-100ua	2901-236513	89536	2901-236513	1		
P1, P2		Line cord	6005-226100	91934	2270	1		
R1		Res, car flm, 90M ±1%, 2w	4703-192138	75042	MEHT-X	1		
R2		Res, car flm, 9M ±0.5%, 1w	4703-107557	75042	Type C13	1		
R3		Res, car flm, 1M ±1%, 1/2w	4703-107219	75042	Type C12	1		
R4		Res, car flm, 90k ±0.5%, 1/2w	4703-107292	75042	Type C12	1		
R5		Res, car flm, 9k ±0.5%, 1/2w	4703-107250	75042	Type C12	1		
R6		Res, car flm, 900Ω ±0.5%, 1/2w	4703-107771	75042	Type C12	1		
R7		Res, car flm, 100Ω ±0.5%, 1/2w	4703-107730	75042	Type C12	1		
R9		Res, comp, 1k ±10%, 1w	4704-109371	01121	GB1021	1		
S1		Switch, rotary, RANGE	5105-242867	89536	5105-242867	1		
S2		Switch, rotary, POWER	5105-242917	89536	5105-242917	1		
S3		Switch, rotary, NULL	5105-242875	89536	5105-242875	1		
S4		Switch, rotary, POLARITY	5105-242883	89536	5105-242883	1		
20		Coupler, power switch	2402-104505	89536	2402-104505	1		
21		Cover, bottom (not illustrated)	3156-230383	89536	3156-230383	1		
22		Cover, top (not illustrated)	3156-230375	89536	3156-230375	1		
23		Dial, 0-9	2403-232215	89536	2403-232215	2		
24		Dial, 0-10	2403-232207	89536	2403-232207	1		
25		Dial, 0-100	2403-242859	89536	2403-242859	1		
26		Foot, plastic (not illustrated)	3155-230037	89536	3155-230037	4		

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
27		Indicator, ON-OFF flag	3158-231886	89536	3158-231886	1		
28		Rack Mounting Kit (not illustrated)	2906-243287	89536	2906-243287	1		
29		Shaft, power switch	2406-231860	89536	2406-231860	1		
30		Tilt stand (not illustrated)	3154-231407	89536	3154-231407	1		
31		Trim strip, front (not illustrated)	3154-230813	89536	3154-230813	2		
32		Trim strip, rear (not illustrated)	3156-231852	89536	3156-231852	2		
33		Trim strip, side insert (not illustrated)	3155-230888	89536	3155-230888	2		

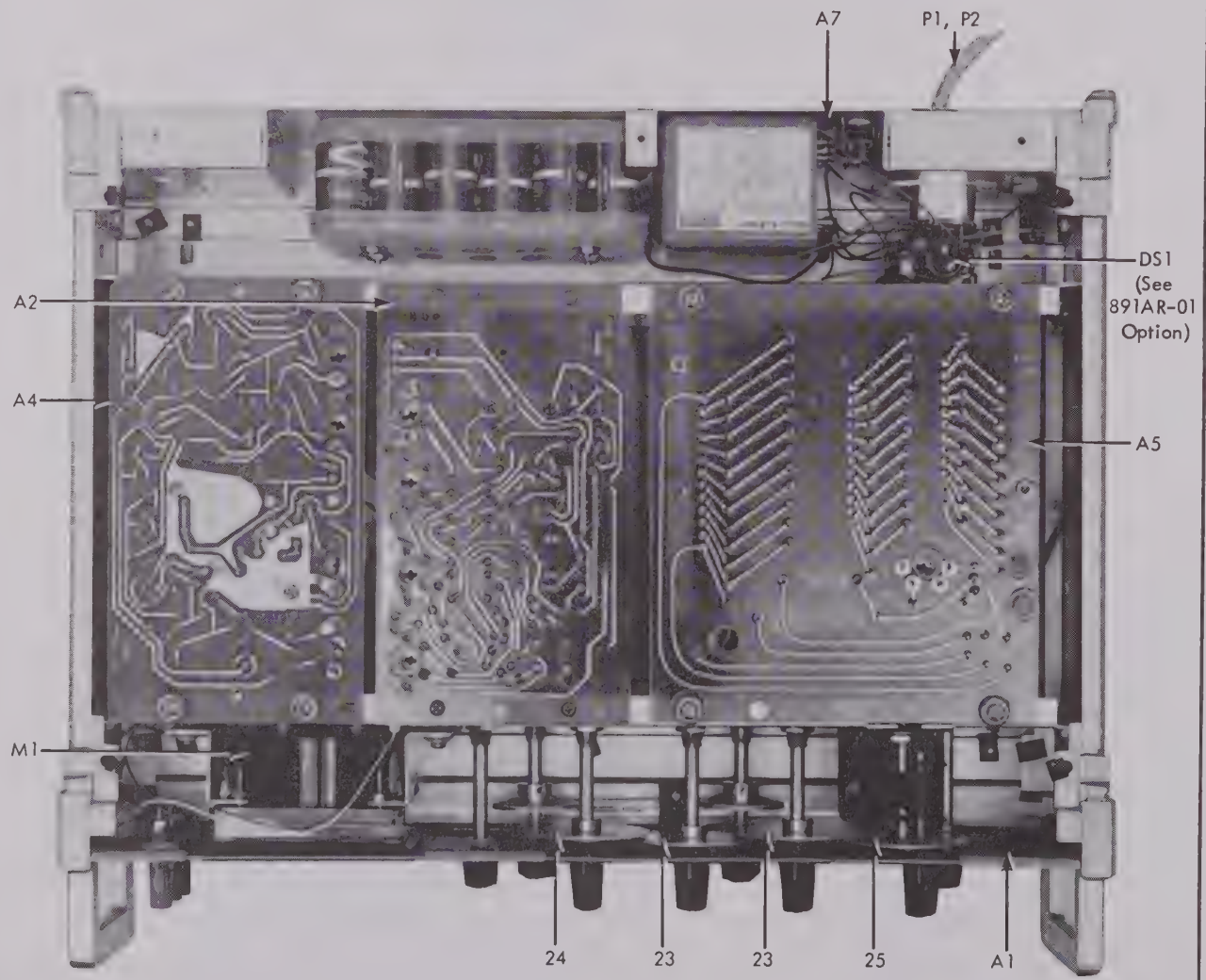


Figure 5-8. 891AR DC DIFFERENTIAL VOLTMETER (Sheet 2 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A1		**FRONT PANEL ASSEMBLY (891AR) Figure 5-9**						
C1		Cap, plstc, 0.047uf ±20%, 1.2kv	1507-182683	99217	MR473L12	2		
J1		Binding post, red, HI	2811-226308	58474	DF21RC	2		
J2		Binding post, red, LO	2811-226308	58474	DF21RC	REF		
J3		Binding post, black, GROUND	2811-226282	58474	DF21BC	1		
R8		Res, comp, 100M ±10%, 1/2w	4704-190520	01121	EB1071	1		
34		Handle	3151-231647	89536	3151-231647	2		
35		Knob, Digit	2405-158949	89536	2405-158949	4		
36		Knob, NULL SENS, POLARITY, RANGE	2405-158956	89536	2405-158956	3		
37		Knob, POWER	2405-235689	89536	2405-235689	1		
38		Link, shorting	2811-101220	24655	938L	1		
39		Panel, front	1406-231787	89536	1406-231787	1		

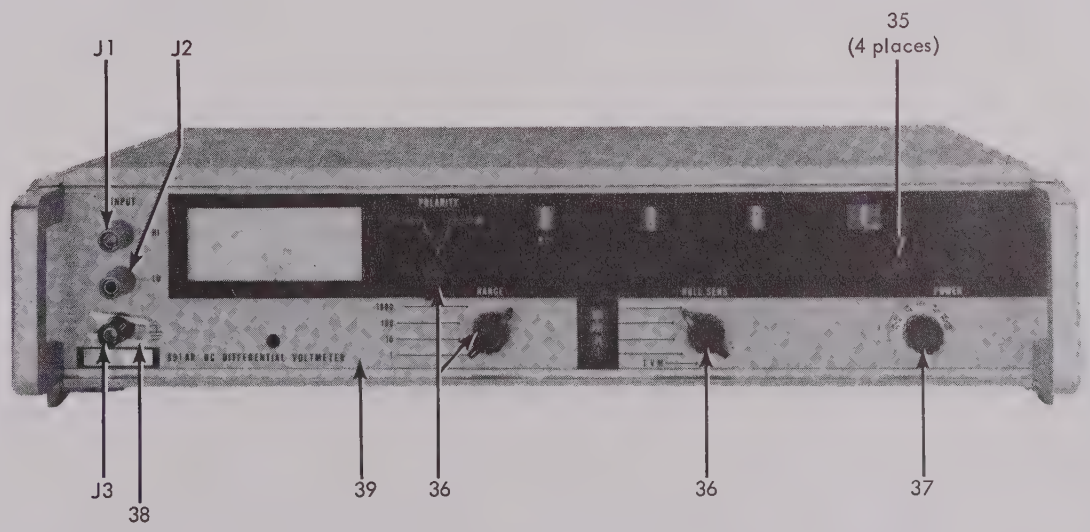


Figure 5-9. FRONT PANEL ASSEMBLY (891AR)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
A7		**REAR PANEL ASSEMBLY (891AR) Figure 5-10**						
CR1		Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	REF		
CR2		Diode, silicon, 1 amp, 100 piv	4802-116111	05277	IN4817	REF		
CR3		Diode, silicon, 1 amp, 100 piv (not illustrated)	4802-116111	05277	IN4817	REF		
CR4		Diode, silicon, 1 amp, 100 piv (not illustrated)	4802-116111	05277	IN4817	REF		
F1		Fuse, slow blow, 1/8 amp, 250v (for 115v operation) (not illustrated)	5105-166488	71400	Type MDL	1	2	
F1		Fuse, slow blow, 1/16 amp, 250v (for 230v operation) (not illustrated)	5105-163030	71400	Type MDL	1	2	
J4		Connector, male, 3 contact	2109-222612	82389	AC3G	1		
S5		Switch, slide	5106-226274	82389	46256-LF	1		
T1		Transformer, power	5602-223990	89536	5602-223990	1		
XF1		Holder, fuse	2102-160846	75915	342004	1		
40		Panel, rear	1406-231795	89536	1406-231795	1		

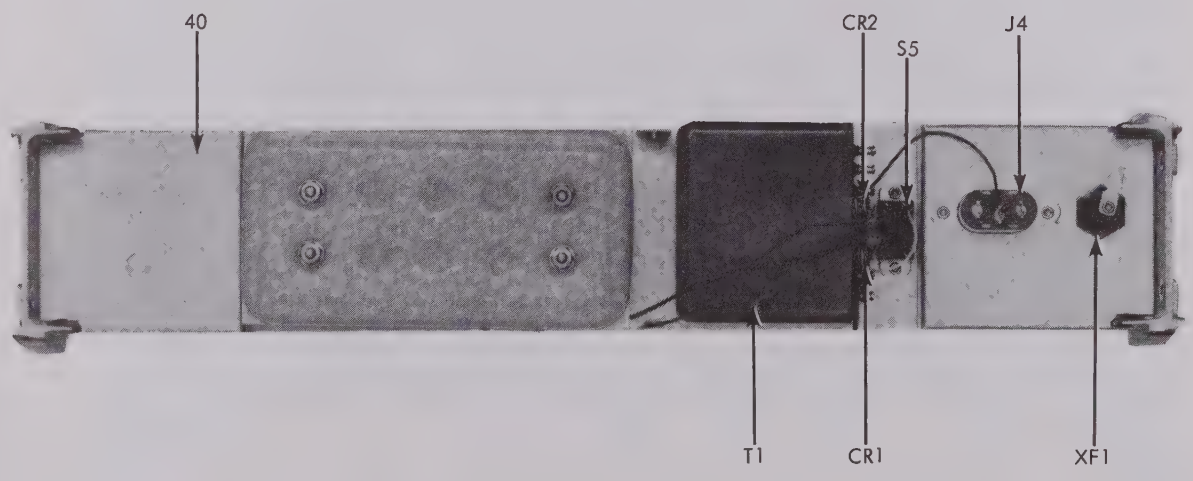


Figure 5-10. REAR PANEL ASSEMBLY (891AR)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		DC DIFFERENTIAL VOLTMETER - BATTERY OPTION - Figure 5-11	891A-01 891AR-01					
		Note: The basic Model 891A or 891AR can be modified in the field by installing the Battery Option Kit, part number 2906-242420. The kit includes BT1, DS1 and the power knob.						
BT1		Battery pack	3158-232496	89536	3158-232496	1		
		Battery, Ni-Cad, 1.2v	4002-160390	83740	C1.2T	18		
		Holder, battery	3155-232488	89536	3155-232488	2		
DS1		Lamp, incandescent, 24v (See Figures 5-1 and 5-8)	3901-218354	71744	1252	1		
		Knob, POWER	2405-235671	89536	2405-235671	1		
		DC DIFFERENTIAL VOLTMETER - RECORDER OUTPUT OPTION Figure 5-11	891A-02 891AR-02					
		Note: The basic Model 891A or 891AR can be modified in the field by installing the Recorder Output Option Kit, part number 2906-242438. The kit includes J5, J6, R10, R11 and the A6 P/C assembly.						
A6		Recorder Output P/C Assembly (See Figure 5-11)	1702-239301 (891A-4201)	89536	1702-239301	1		
J5		Binding post, red, HI	2811-226308	58474	DF21RC	1		
J6		Binding post, black, LO	2811-226282	58474	DF21BC	1		
R10		Res, var, comp, 10k ±20%, 1/2w	4701-162800	12697	Series 37	1		
R11		Res, comp, 10k ±5%, 1/4w (mounted on R10)	4704-148106	01121	CB1035	1		
A6		RECORDER OUTPUT P/C ASSEMBLY Figure 5-11	1702-239301 (891A-4201)	89536	1702-239301	REF		
C1		Cap, elect, 10uf +50/-10%, 25v	1502-170266	73445	C426ARF10	1	1	
Q1		Tstr, germanium, NPN	4805-182691	01295	GA2875	2	1	
Q2		Tstr, germanium, PNP	4805-182709	01295	GA2877	2	1	
Q3		Tstr, germanium, PNP	4805-182709	01295	GA2877	REF		
Q4		Tstr, germanium, NPN	4805-182691	01295	GA2875	REF		

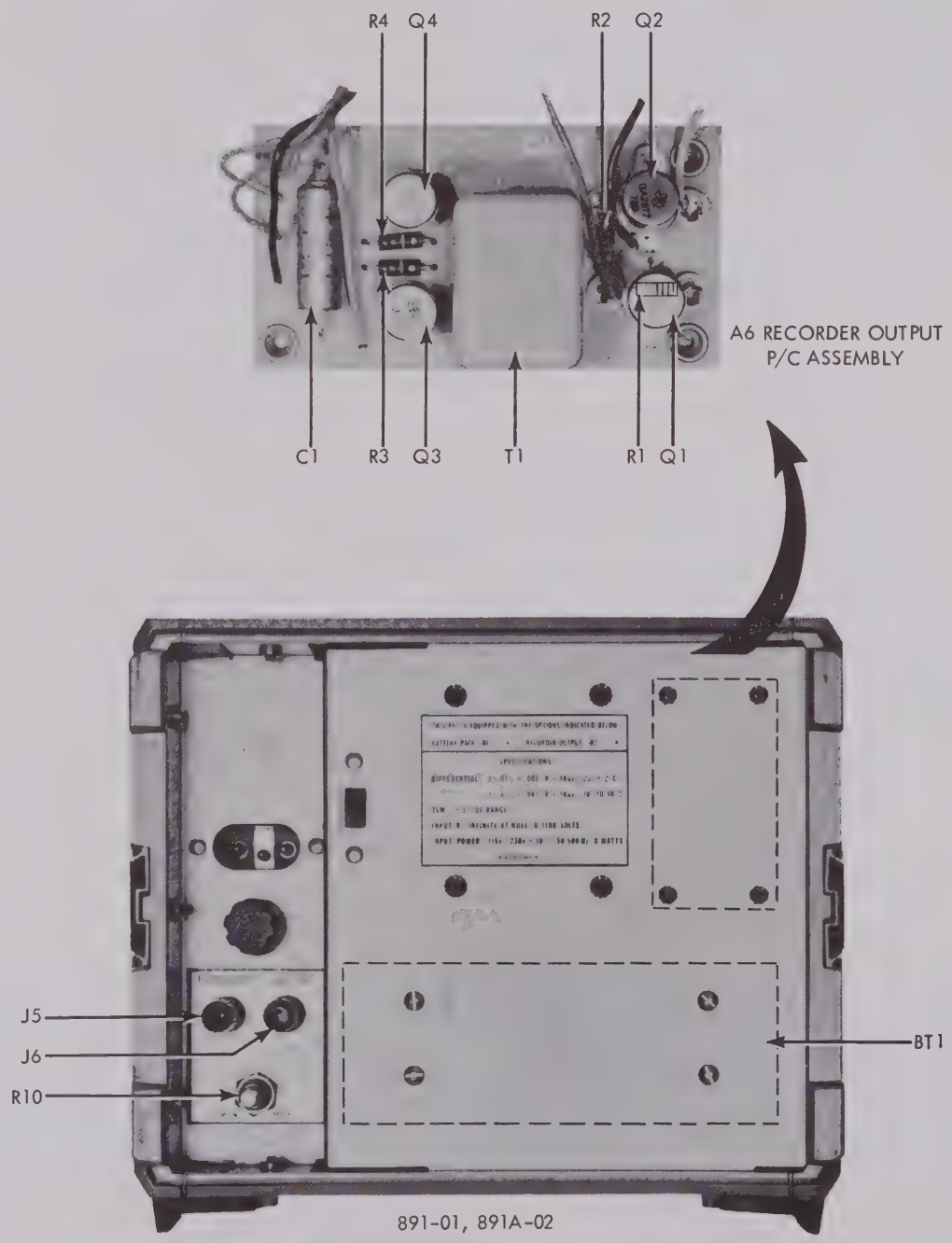


Figure 5-11. BATTERY AND RECORDER OUTPUT OPTIONS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
R1		Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	4		
R2		Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	REF		
R3		Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	REF		
R4		Res, comp, 22k ±5%, 1/4w	4704-148130	01121	CB2235	REF		
T1		Transformer, recorder output	5602-242347	89536	5602-242347	1		

5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 891A and 891AR. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123.

USE CODE	EFFECTIVITY
NO CODE	Model 891A and 891AR serial number 123 and on.
A	Model 891A and 891AR serial number 123 thru 125.
B	Model 891A and 891AR serial number 126 and on.
C	Model 891A and 891AR serial number 123 thru 262.
D	Model 891A and 891AR serial number 263 and on.
E	Model 891A and 891AR serial number 123 thru 267.
F	Model 891A and 891AR serial number 268 and on.
G	Model 891A serial number 123 thru 237. Model 891AR serial number 123 thru 192.
H	Model 891A serial number 238 and on. Model 891AR serial number 193 and on.

APPENDIX A

FEDERAL SUPPLY CODE FOR MANUFACTURERS

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Westlake, Ohio
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisberg, Pennsylvania
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01281	TRW Semiconductors Lawndale, California
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01686	RCL Electronics Inc. Manchester, New Hampshire
01730	Deleted
01884	Dearborn Electronics Inc. Orlando, Florida
02114	Ferroxcube Corp. Saugerties, New York
02606	Replaced by 15801
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02799	Arco Capacitors, Inc. Los Angeles, California
03614	Replaced by 71400
03651	Replaced by 44655
03797	Eldema Corp. Compton, California
03877	Transitron Electronic Corp. Wakefield, Massachusetts
03888	Pyrofilm Resistor Co., Inc. Cedar Knolls, New Jersey
03911	Clairex Corp. New York, New York
03980	Muirhead Instruments, Inc. Mountainside, New Jersey
04009	Arrow Hart and Hegemen Electronic Company Hartford, Connecticut
04062	Replaced by 72136
04202	Replaced by 81312
04217	Essex Wire Corp. Wire & Cable Div. Anaheim, California
04221	Aemco Div. of Midtex Inc. Mankato, Minnesota
04645	Replaced by 75376
04713	Motorola Semiconductor Products Inc. Phoenix, Arizona
05082	Replaced by 94154
05236	Jonathan Mfg. Co. Fullerton, California
05277	Westinghouse Electric Corp. Semiconductor Dept. Youngwood, Pennsylvania
05278	Replaced by 43543
05397	Union Carbide Corp. Electronics Div. Cleveland, Ohio
05571	Sprague Electric Co Pacific Div. Los Angeles, California
05704	Alac, Inc. Glendale, California
05820	Wakefield Engineering Ind. Wakefield, Massachusetts
06001	General Electric Company Capacitor Department Irmo, South Carolina
06136	Replaced by 63743
06473	Amphenol Space & Missile Sys. Chatsworth, California
06555	Beede Electrical Instrument Co. Penacook, New Hampshire
06739	Electron Corp. Littletown, Colorado
06743	Clevite Corp. Cleveland, Ohio
06751	Semcor Div. Components Phoenix, Arizona
06860	Gould National Batteries Inc. City of Industry, California
06980	Eitel-McCullough, Inc. San Carlos, California
07115	Replaced by 14674
07138	Westinghouse Electric Corp. Electronic Tube Div. Elmira, New York
07263	Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
07344	Bircher Co., Inc. Rochester, New York
07792	Lerma Engineering Corp. Northampton, Massachusetts
07910	Continental Device Corp. Hawthorne, California
08530	Reliance Mica Corp. Brooklyn, New York
08792	CBS Electronics Semiconductor Operations-Div. of CBS Inc. Lowell, Massachusetts
08806	General Electric Co. Miniature Lamp Dept. Cleveland, Ohio
08863	Nylomatic Corp. Norrisville, Pennsylvania
08988	Skottie Electronics Inc. Archbald, Pennsylvania
09922	Burndy Corp. Norwalk, Connecticut
11237	Chicago Telephone of Calif. Inc. South Pasadena, California
11358	CBS Electronics Div. of CBS Inc. Newburyport, Massachusetts
11403	Best Products Co. Chicago, Illinois
11503	Keystone Mfg Div. of Avis Industrial Corp. Warren, Michigan
12014	Chicago Rivet & Machine Co. Bellwood, Illinois
12040	National Semiconductor Corp. Danburry, Connecticut
12060	Diodes, Inc. Chatsworth, California
12136	Philadelphia Handle Co. Camden, New Jersey
12323	Presin Co., Inc. Shelton, Connecticut
12327	Freeway Washer & Stamping Co. Cleveland, Ohio
12400	Replaced by 75042
12617	Hamlin Inc. Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Dover, New Hampshire
12749	James Electronics Chicago, Illinois

12856	Micrometals Sierra Madre, California
12954	Dickson Electronics Corp. Scottsdale, Arizona
13606	Sprague Electric Co. Transistor Div. Concord, New Hampshire
13839	Replaced by 23732
14099	Semtech Corp. Newbury Park, California
14193	California Resistor Corp. Santa Monica, California
14298	American Components, Inc. Conshohocken, Pennsylvania
14655	Cornell-Dubilier Electronics Newark, New Jersey
14674	Corning Glass Works Corning, New York
14752	Electro Cube Inc. San Gabriel, California
14869	Replaced by 96853
15636	Elec-Trol Inc. Northridge, California
15801	Fenwal Electronics Inc. Framingham, Massachusetts
15818	Amelco Semiconductor Div. of Teledyne Inc. Mountain View, California
15849	Useco, Inc. Mt. Vernon, New York
15909	Replaced by 17870
16332	Replaced by 28478
16473	Cambridge Scientific Ind. Inc. Cambridge, Maryland
16742	Paramount Plastics Downey, California
16758	Delco Radio Div. of General Motors Kokomo, Indiana
17069	Circuit Structures Lab. Upland, California
17856	Siliconix, Inc. Sunnyvale, California
17870	Daven-Div. of Thomas A. Edison Ind.--McGraw-Edison Co. Manchester, New Hampshire
18083	Deleted
18178	Vactec Inc. Maryland Heights, Missouri
18736	Voltronics Corp. Hanover, New Jersey
19429	Montronics, Inc. Seattle, Washington
19451	Perine Machinery & Supply Co. Seattle, Washington
19701	Electra Mfg. Co. Independence, Kansas
20584	Enochs Mfg. Co. Indianapolis, Indiana
22767	ITT Semiconductors Div. of ITT Palo Alto, California
23732	Tracor Rockville, Maryland
24248	Southco Div. of South Chester Corp. Lester, Pennsylvania
24655	General Radio Co. West Concord, Massachusetts
25403	Amperex Electronic Corp Semiconductor & Receiving Tube Division Slatersville, Rhode Island
28478	Deltrol Controls Corp. Milwaukee, Wisconsin
28520	Heyman Mfg. Co. Kenilworth, New Jersey
30323	Illinois Tool Works Inc. Chicago, Illinois
33173	General Electric Co. Tube Dept. Owensboro, Kentucky
37942	Mallory, P. R., & Co., Inc. Indianapolis, Indiana
38315	Honeywell Inc. Precision Meter Div. Manchester, New Hampshire
42498	National Company Melrose, Massachusetts
43543	Nytronics Inc. Transformer Co. Div. Alpha, New Jersey
44655	Ohmite Mfg. Co. Skokie, Illinois
49671	Radio Corp. of America New York, New York
49956	Raytheon Company Lexington, Maine
53021	Sangamo Electric Co. Springfield, Illinois
55026	Simpson Electric Company Chicago, Illinois
56289	Sprague Electric Co. North Adams, Massachusetts
58474	Superior Electric Co. Bristol, Connecticut
60399	Torrington Mfg. Co. Torrington, Connecticut
62460	Deleted
63743	Ward Leonard Electric Co. Mount Vernon, New York
64834	West Mfg. Co. San Francisco, California
65092	Weston Instruments Inc. Newark, New Jersey
66150	Winslow Tele-Tronics Inc. Asbury Park, New Jersey
70563	Amperite Company Union City, New Jersey
70903	Belden Mfg. Co. Chicago, Illinois
71002	Birnbach Radio Co., Inc. New York, New York
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
71468	ITT Cannon Electric Inc. Los Angeles, California
71482	Clare, C. P. & Co. Chicago, Illinois
71590	Centralab Div. of Globe Union Inc. Milwaukee, Wisconsin
71707	Coto Coil Co., Inc. Providence, Rhode Island
71744	Chicago Miniature Lamp Works Chicago, Illinois
71785	Cinch Mfg. Co. & Howard B. Jones Div. Chicago, Illinois
72005	Driver, Wilber B., Co. Newark, New Jersey
72092	Replaced by 06980
72136	Electro Motive Mfg. Co. Willimantic, Connecticut
72259	Nytronics Inc. Berkeley Heights, New Jersey
72354	Deleted
72619	Dialight Corp Brooklyn, New York
72653	G. C. Electronics Rockford, Illinois
72665	Replaced by 90303
72794	Dzus Fastener Co., Inc. West Islip, New York
72928	Gudeman Co. Chicago, Illinois
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73293	Hughes Aircraft Co. Electron Dynamics Div. Newport Beach, California
73445	Amperex Electronic Corp. Hicksville, New York
73559	Carling Electric Inc. Hartford, Connecticut
73586	Circle F Industries Trenton, New Jersey
73734	Federal Screw Products, Inc. Chicago, Illinois
73743	Fischer Special Mfg. Co. Cincinnati, Ohio
73899	JFD Electronics Co. Brooklyn, New York
73949	Guardian Electric Mfg. Co. Chicago, Illinois
74199	Quam Nichols Co. Chicago, Illinois
74217	Radio Switch Corp. Marlboro, New Jersey
74276	Signalite Inc. Neptune, New Jersey
74306	Piezo Crystal Co. Carlisle, Pennsylvania
74542	Hoyt Elect. Instr. Works Penacook, New Hampshire
74970	Johnson, E. F., Co. Waseca, Minnesota
75042	IRC Inc. Philadelphia, Pennsylvania
75376	Kurz-Kasch, Inc. Dayton, Ohio
75382	Kulka Electric Corp. Mt. Vernon, New York
75915	Littleluse Inc. Des Plaines, Illinois
76854	Oak Mfg. Co. Crystal Lake, Illinois
77342	Potter & Brumfield Div. of Amer. Machine & Foundry Princeton, Indiana
77969	Rubbercraft Corp. of Calif. LTD. Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
St. Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components & Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co.
Kansas City, Missouri

90211 Square D Co.
Chicago, Illinois

90303 Mallory Battery Co.
Tarrytown, New York

91293 Johanson Mfg. Co.
Boonton, New Jersey

91407 Replaced by 58474

91637 Dale Electronics Inc.
Columbus, Nebraska

91662 Elco Corp.
Willow Grove, Pennsylvania

91737 Gremar Mfg. Co., Inc.
Wakefield, Massachusetts

91802 Industrial Devices, Inc.
Edgewater, New Jersey

91836 King's Electronics
Tuckahoe, New York

91929 Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934 Miller Electric Co., Inc.
Pawtucket, Rhode Island

93332 Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145 Replaced by 49956

94154 Tung-Sol
Div. of Wagner Electric Corp.
Newark, New Jersey

95146 Alco Electronics Products Inc.
Lawrence, Massachusetts

95263 Leecraft Mfg. Co.
Long Island City, New York

95264 Replaced by 98278

95275 Vitramon Inc.
Bridgeport, Connecticut

95303 Radio Corp. of America
Solid State & Receiving Tube Div.
Cincinnati, Ohio

95354 Methode Mfg. Corp.
Rolling Meadows, Illinois

95712 Dage Electric Co., Inc.
Franklin, Indiana

95987 Weckesser Co., Inc.
Chicago, Illinois

96733 San Fernando Electric Mfg. Co.
San Fernando, California

96853 Rustrak Instrument Co.
Manchester, New Hampshire

96881 Thomson Industries, Inc.
Manhasset, New York

97540 Master Mobile Mounts
Div. of Whitehall Electronics Corp.
Los Angeles, California

97913 Industrial Electronic Hdware Corp.
New York, New York

97945 White, S. S. Co.
Plastics Div.
New York, New York

97966 Replaced by 11358

98094 Replaced by 49956

98278 Microdot Inc.
Pasadena, California

98291 Sealectro Corp.
Conhex Div
Mamaroneck New York

98388 Accurate Rubber & Plastics
Culver City, California

98743 Replaced by 12749

98925 Deleted

99120 Plastic Capacitors, Inc.
Chicago, Illinois

99217 Southern Electronics Corp.
Burbank, California

99515 Marshall Industries
Capacitor Div.
Monrovia, California

Revised August 1, 1968
Using H4-1 and H4-2
Dated June , 1968

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

Sales and Service Representatives

ALABAMA

HUNTSVILLE
BCS Associates, Inc.
2317 Bob Wallace Ave. S.W.
Tel. (205) 534-1648

ALASKA

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Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington
Tel. (206) 767-4260

ARIZONA

PHOENIX
Barnhill Associates
4900 E. Indian School Road
Tel. (602) 959-2115

CALIFORNIA

LOS ANGELES
Instrument Specialists, Inc.
2870 Los Feliz Place
Tel. (213) 665-5181

SAN FRANCISCO
Instrument Specialists, Inc.
2359 De La Cruz
Santa Clara, California
Tel. (408) 244-1505

COLORADO

DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel (303) 934-5505

CONNECTICUT

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Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, Connecticut
Tel. (203) 633-0777

FLORIDA

ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 425-2764

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Industrial Electronics, Inc.
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Tel. (808) 506-095

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Rosemont, Illinois
Tel. (312) 825-1144

INDIANA

INDIANAPOLIS
Cozzens & Cudahy, Inc.
44 Kirk Drive
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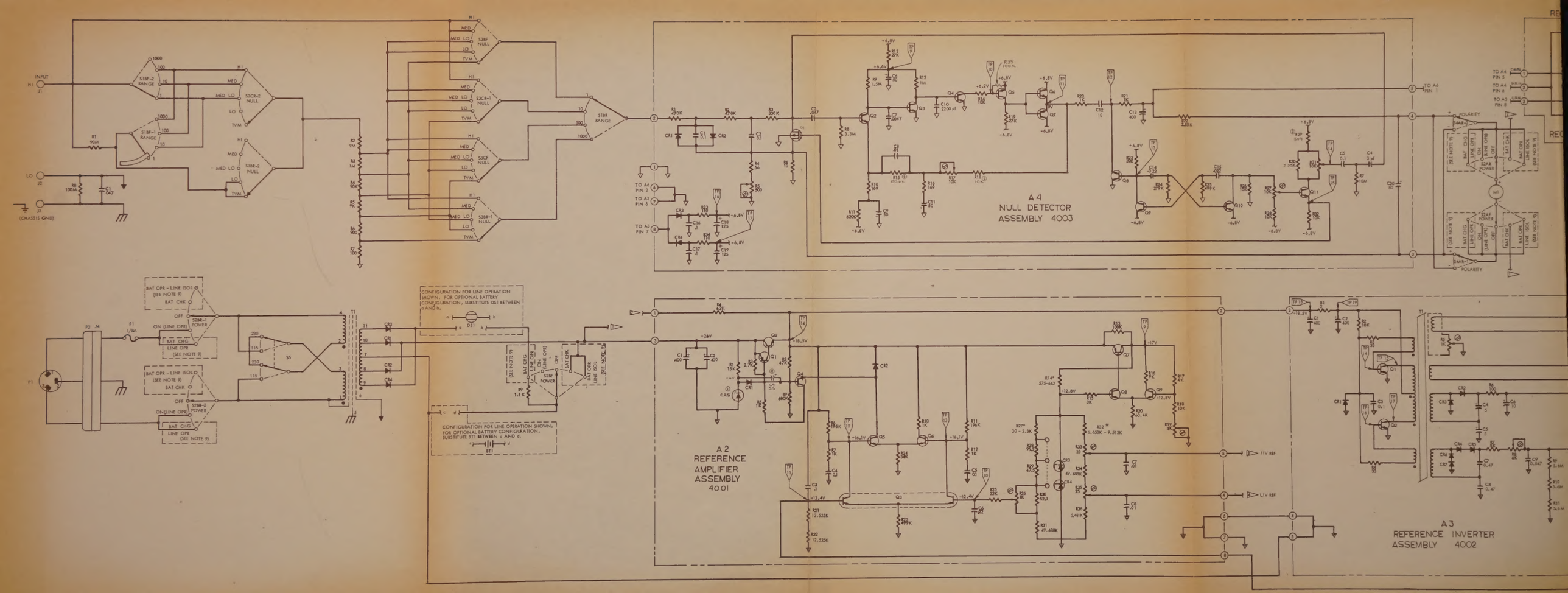
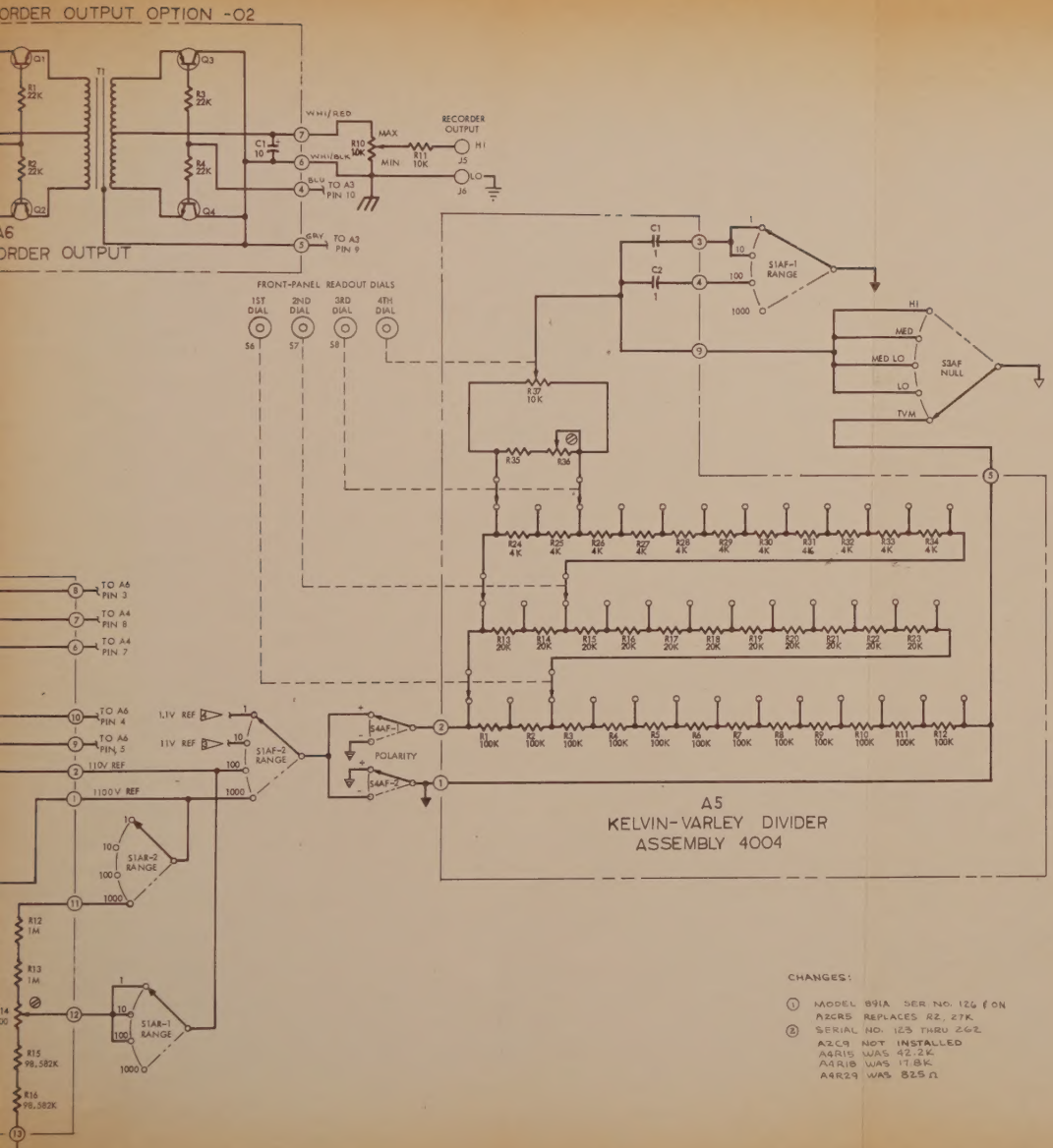

A 4
NULL DETECTOR
ASSEMBLY 4003
A 2
REFERENCE
AMPLIFIER
ASSEMBLY
4001
A 3
REFERENCE INVERTER
ASSEMBLY 4002
INPUT
CONFIGURATION FOR LINE OPERATION SHOWN, FOR OPTIONAL BATTERY CONFIGURATION, SUBSTITUTE DS1 BETWEEN a AND b.
CONFIGURATION FOR LINE OPERATION SHOWN, FOR OPTIONAL BATTERY CONFIGURATION, SUBSTITUTE BT1 BETWEEN c AND d.
BAT OPR - LINE ISOL Ø (SEE NOTE 9)
BAT CHK
LINE OPR (SEE NOTE 9)
ON (LINE OPR)
OFF
POLARITY
+11V REF
-11V REF



11. BELOW IS A BRIEF EXPLANATION OF THE COMPLETE REFERENCE DESIGNATIONS OF SWITCHES S1 THRU S4. NULL SWITCH S3BR-2 IS USED AS AN EXAMPLE.

    (S3) THE BASIC REFERENCE DESIGNATION.
    (B) THE SWITCH DECK LOCATION AS VIEWED FROM THE FRONT-PANEL. "B" IS THE SECOND DECK FROM THE FRONT-PANEL OF SWITCH S3.
    (R) "R" INDICATES THE REAR SECTION OF THE ABOVE DECK. AN "F" INDICATES THE FRONT SECTION.
    (-2) INDICATES WHICH FUNCTION OF THE ABOVE DECK SECTION IS ILLUSTRATED. NO NUMBER IN THIS POSITION INDICATES THAT ONLY ONE FUNCTION IS ACCOMPLISHED BY THE DECK SECTION.

10. ALL VOLTAGE MEASUREMENTS SHOWN ARE TAKEN UNDER THE FOLLOWING CONDITIONS:

    (A) POWER SWITCH IN LINE OPERATE
    (B) LINE VOLTAGE AT 115/230 VOLTS, 50-440 HERTZ.
    (C) ALL VOLTAGES MEASURED WITH A 3% 10 MEGOHM VOLTMETER FROM SPECIFIED TERMINAL TO REFERENCE SUPPLY-NULL DETECTOR COMMON. THE COMMON POST IS REFERENCE SUPPLY-NULL DETECTOR COMMON WHEN IN THE TVM MODE OR WHEN IN A NULL MODE WITH ALL VOLTAGE DIALS SET TO 0 AND POLARITY SWITCH SET TO + .
    (D) SOME VOLTAGES MAY VARY AS MUCH AS 15 TO 20%.
    (E) BIAS VOLTAGES (DIFFERENCE BETWEEN EMMITER AND BASE VOLTAGES) SHOULD REMAIN APPROXIMATELY THE SAME.
    (F) ALL VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.

9. POWER SWITCH (S2) POSITIONS WITHIN DASHED LINES ARE USED ONLY IN UNITS CONTAINING THE OPTIONAL RECHARGEABLE BATTERY SUPPLY.

8. ALL RESISTANCE VALUES ARE IN OHMS AND ALL CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE INDICATED.

7. ▷ FLAGS WITH THE SAME NUMBERS ARE CONNECTED.

6. TP TEST POINT

5. INTERNAL ADJUSTMENT

4. FACTORY SELECTED COMPONENT

3. 1.1V, 11V, 110V, & 1100V REFERENCE COMMON

2. NULL DETECTOR COMMON

1. LO INPUT COMMON

CHANGES:

① MODEL 891A SER NO. 126 & ON
A2CR5 REPLACES R2, 27K.
② SERIAL NO. 123 THRU 262
A2C9 NOT INSTALLED
A4R15 WAS 42.2K
A4R18 WAS 17.8K
A4R29 WAS 825Ω

FUNCTIONAL SCHEMATIC d

DC DIFFERENTIAL VOLTMETER

MODELS 891A & 891AR

SER. NO. 123 & ON

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